

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

PHYSICAL SETTING CHEMISTRY

Thursday, January 24, 2008 — 1:15 to 4:15 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 quantity identifies an element?
 - atomic number
 - mass number
 - total number of neutrons in an atom of the element
 - total number of valence electrons in an atom of the element
- Which atom in the ground state has a partially filled second electron shell?
 - hydrogen atom
 - lithium atom
 - potassium atom
 - sodium atom
- What is the total charge of the nucleus of a nitrogen atom?
 - +5
 - +2
 - +7
 - +14
- Which value of an element is calculated using both the mass and the relative abundance of each of the naturally occurring isotopes of this element?
 - atomic number
 - atomic mass
 - half-life
 - molar volume
- The mass of 12 protons is approximately equal to
 - 1 atomic mass unit
 - 12 atomic mass units
 - the mass of 1 electron
 - the mass of 12 electrons
- Sodium atoms, potassium atoms, and cesium atoms have the same
 - atomic radius
 - first ionization energy
 - total number of protons
 - oxidation state
- Which statement describes a chemical property of hydrogen gas?
 - Hydrogen gas burns in air.
 - Hydrogen gas is colorless.
 - Hydrogen gas has a density of $0.000\ 09\ \text{g/cm}^3$ at STP.
 - Hydrogen gas has a boiling point of 20. K at standard pressure.
- Which element has the greatest density at STP?
 - calcium
 - carbon
 - chlorine
 - copper
- Which equation shows conservation of atoms?
 - $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
 - $\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - $2\text{H}_2 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- Which term indicates how strongly an atom attracts the electrons in a chemical bond?
 - alkalinity
 - atomic mass
 - electronegativity
 - activation energy
- A solid substance is an excellent conductor of electricity. The chemical bonds in this substance are most likely
 - ionic, because the valence electrons are shared between atoms
 - ionic, because the valence electrons are mobile
 - metallic, because the valence electrons are stationary
 - metallic, because the valence electrons are mobile

- 12 Magnesium nitrate contains chemical bonds that are
- (1) covalent, only
 - (2) ionic, only
 - (3) both covalent and ionic
 - (4) neither covalent nor ionic
- 13 Which substance can be broken down by a chemical change?
- (1) antimony
 - (2) carbon
 - (3) hexane
 - (4) sulfur
- 14 Which barium salt is *insoluble* in water?
- (1) BaCO₃
 - (2) BaCl₂
 - (3) Ba(ClO₄)₂
 - (4) Ba(NO₃)₂
- 15 Which unit can be used to express solution concentration?
- (1) J/mol
 - (2) L/mol
 - (3) mol/L
 - (4) mol/s
- 16 Under which conditions of temperature and pressure is a gas most soluble in water?
- (1) high temperature and low pressure
 - (2) high temperature and high pressure
 - (3) low temperature and low pressure
 - (4) low temperature and high pressure
- 17 Given the equation representing a system at equilibrium:
- $$\text{H}_2\text{O}(s) \rightleftharpoons \text{H}_2\text{O}(\ell)$$
- At which temperature does this equilibrium exist at 101.3 kilopascals?
- (1) 0 K
 - (2) 0°C
 - (3) 32 K
 - (4) 273°C
- 18 In a redox reaction, the total number of electrons lost is
- (1) less than the total number of electrons gained
 - (2) greater than the total number of electrons gained
 - (3) equal to the total number of electrons gained
 - (4) equal to the total number of protons gained
- 19 Which formula represents an alkene?
- (1) C₂H₆
 - (2) C₃H₆
 - (3) C₄H₁₀
 - (4) C₅H₁₂
- 20 Which term refers to the difference between the potential energy of the products and the potential energy of the reactants for any chemical change?
- (1) heat of deposition
 - (2) heat of fusion
 - (3) heat of reaction
 - (4) heat of vaporization
- 21 Which energy conversion occurs in a voltaic cell?
- (1) chemical energy to electrical energy
 - (2) chemical energy to nuclear energy
 - (3) electrical energy to chemical energy
 - (4) nuclear energy to electrical energy
- 22 Which metal is more active than Ni and *less* active than Zn?
- (1) Cu
 - (2) Cr
 - (3) Mg
 - (4) Pb
- 23 As water is added to a 0.10 M NaCl aqueous solution, the conductivity of the resulting solution
- (1) decreases because the concentration of ions decreases
 - (2) decreases, but the concentration of ions remains the same
 - (3) increases because the concentration of ions decreases
 - (4) increases, but the concentration of ions remains the same
- 24 Which substance is an Arrhenius acid?
- (1) Ba(OH)₂
 - (2) CH₃COOCH₃
 - (3) H₃PO₄
 - (4) NaCl
- 25 Which compound releases hydroxide ions in an aqueous solution?
- (1) CH₃COOH
 - (2) CH₃OH
 - (3) HCl
 - (4) KOH

- 26 Which reaction converts an atom of one element to an atom of another element?
(1) combustion (3) saponification
(2) polymerization (4) transmutation
- 27 Which nuclear emission has the greatest mass?
(1) alpha particle (3) gamma ray
(2) beta particle (4) positron
- 28 Which two radioisotopes have the same decay mode?
(1) ^{37}Ca and ^{53}Fe (3) ^{37}K and ^{42}K
(2) ^{220}Fr and ^{60}Co (4) ^{99}Tc and ^{19}Ne
- 29 Which list of nuclear emissions is arranged in order from the *least* penetrating power to the greatest penetrating power?
(1) alpha particle, beta particle, gamma ray
(2) alpha particle, gamma ray, beta particle
(3) gamma ray, beta particle, alpha particle
(4) beta particle, alpha particle, gamma ray
- 30 One benefit of nuclear fission reactions is
(1) nuclear reactor meltdowns
(2) storage of waste materials
(3) biological exposure
(4) production of energy
-

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 Which list of elements consists of metalloids, only?

- (1) B, Al, Ga (3) O, S, Se
(2) C, N, P (4) Si, Ge, As

32 Which two notations represent different isotopes of the same element?

- (1) ${}^6_4\text{Be}$ and ${}^9_4\text{Be}$ (3) ${}^{14}_7\text{N}$ and ${}^{14}_6\text{C}$
(2) ${}^7_3\text{Li}$ and ${}^7_3\text{Li}$ (4) ${}^{32}_{15}\text{P}$ and ${}^{32}_{16}\text{S}$

33 Which general trend is found in Period 2 on the Periodic Table as the elements are considered in order of increasing atomic number?

- (1) decreasing atomic mass
(2) decreasing electronegativity
(3) increasing atomic radius
(4) increasing first ionization energy

34 What is the gram-formula mass of $\text{Ca}_3(\text{PO}_4)_2$?

- (1) 248 g/mol (3) 279 g/mol
(2) 263 g/mol (4) 310. g/mol

35 What is the total number of pairs of electrons shared between the carbon atom and the oxygen atom in a molecule of methanal?

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

36 When sodium and fluorine combine to produce the compound NaF, the ions formed have the same electron configuration as atoms of

- (1) argon, only
(2) neon, only
(3) both argon and neon
(4) neither argon nor neon

37 In which compound is the ratio of metal ions to nonmetal ions 1 to 2?

- (1) calcium bromide (3) calcium phosphide
(2) calcium oxide (4) calcium sulfide

38 What is the concentration of $\text{O}_2(\text{g})$, in parts per million, in a solution that contains 0.008 gram of $\text{O}_2(\text{g})$ dissolved in 1000. grams of $\text{H}_2\text{O}(\ell)$?

- (1) 0.8 ppm (3) 80 ppm
(2) 8 ppm (4) 800 ppm

39 The table below shows data for the temperature, pressure, and volume of four gas samples.

Data for Four Gas Samples

Gas Sample	Temperature (K)	Pressure (atm)	Volume (mL)
A	100.	2	400.
B	200.	2	200.
C	100.	2	400.
D	200.	4	200.

Which two gas samples have the same total number of molecules?

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

40 At which temperature is the vapor pressure of ethanol equal to the vapor pressure of propanone at 35°C ?

- (1) 35°C (3) 82°C
(2) $60.^\circ\text{C}$ (4) 95°C

- 41 A rigid cylinder with a movable piston contains a 2.0-liter sample of neon gas at STP. What is the volume of this sample when its temperature is increased to 30.°C while its pressure is decreased to 90. kilopascals?
- (1) 2.5 L (3) 1.6 L
(2) 2.0 L (4) 0.22 L
- 42 Which compound is a saturated hydrocarbon?
- (1) CH₂CH₂ (3) CH₃CHO
(2) CH₃CH₃ (4) CH₃CH₂OH
- 43 A molecule of a compound contains a total of 10 hydrogen atoms and has the general formula C_nH_{2n+2}. Which prefix is used in the name of this compound?
- (1) but- (3) oct-
(2) dec- (4) pent-
- 44 Reduction occurs at the cathode in
- (1) electrolytic cells, only
(2) voltaic cells, only
(3) both electrolytic cells and voltaic cells
(4) neither electrolytic cells nor voltaic cells
- 45 What are the products of a reaction between KOH(aq) and HCl(aq)?
- (1) H₂ and KClO (3) KH and HClO
(2) H₂O and KCl (4) KOH and HCl
- 46 Which volume of 0.10 M NaOH(aq) exactly neutralizes 15.0 milliliters of 0.20 M HNO₃(aq)?
- (1) 1.5 mL (3) 3.0 mL
(2) 7.5 mL (4) 30. mL
- 47 Which indicator, when added to a solution, changes color from yellow to blue as the pH of the solution is changed from 5.5 to 8.0?
- (1) bromocresol green (3) litmus
(2) bromthymol blue (4) methyl orange
- 48 The pH of an aqueous solution changes from 4 to 3 when the hydrogen ion concentration in the solution is
- (1) decreased by a factor of $\frac{3}{4}$
(2) decreased by a factor of 10
(3) increased by a factor of $\frac{4}{3}$
(4) increased by a factor of 10
- 49 Which fraction of an original 20.00-gram sample of nitrogen-16 remains unchanged after 36.0 seconds?
- (1) $\frac{1}{5}$ (3) $\frac{1}{16}$
(2) $\frac{1}{8}$ (4) $\frac{1}{32}$
- 50 Which radioactive isotope is used in treating cancer?
- (1) carbon-14 (3) lead-206
(2) cobalt-60 (4) uranium-238

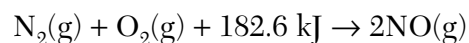
Part B-2

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 Describe *one* chemical property of Group 1 metals that results from the atoms of each metal having only one valence electron. [1]

52 Given the balanced equation representing a reaction:



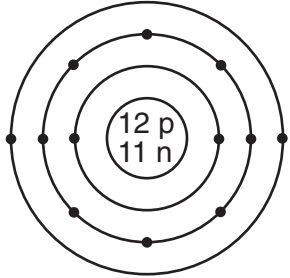
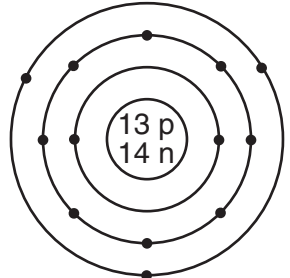
On the labeled axes *in your answer booklet*, draw a potential energy diagram for this reaction. [1]

53 Write *one* electron configuration for an atom of silicon in an excited state. [1]

54 Write the empirical formula for the compound C_8H_{18} . [1]

Base your answers to questions 55 through 57 on the information below.

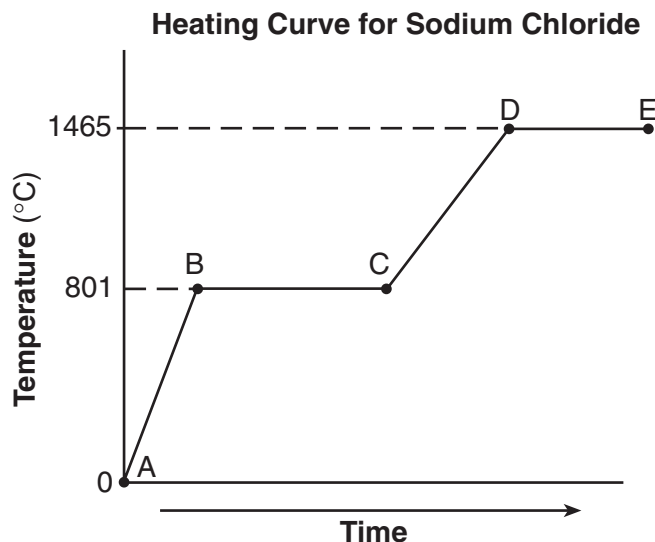
Atomic Diagrams of Magnesium and Aluminum

Key • = electron	Element	Lewis Electron-Dot Diagram	Electron-Shell Diagram
	magnesium	Mg:	
	aluminum	Al:	

- 55 Identify *one* piece of information shown in the electron-shell diagrams that is *not* shown in the Lewis electron-dot diagrams. [1]
- 56 Determine the mass number of the magnesium atom represented by the electron-shell diagram. [1]
- 57 Explain why Lewis electron-dot diagrams are generally more suitable than electron-shell diagrams for illustrating chemical bonding. [1]
-

Base your answers to questions 58 through 60 on the information below.

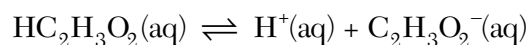
A 100.0-gram sample of NaCl(s) has an initial temperature of 0°C. A chemist measures the temperature of the sample as it is heated. Heat is *not* added at a constant rate. The heating curve for the sample is shown below.



- 58 Determine the temperature range over which the entire NaCl sample is a liquid. [1]
- 59 Identify *one* line segment on the curve where the average kinetic energy of the particles of the NaCl sample is changing. [1]
- 60 Identify *one* line segment on the curve where the NaCl sample is in a single phase and capable of conducting electricity. [1]
-

Base your answers to questions 61 through 63 on the information below.

A beaker contains 100.0 milliliters of a dilute aqueous solution of ethanoic acid at equilibrium. The equation below represents this system.



- 61 Compare the rate of the forward reaction to the rate of the reverse reaction for this system. [1]
- 62 Describe what happens to the concentration of $\text{H}^+(\text{aq})$ when 10 drops of concentrated $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$ are added to this system. [1]
- 63 In the space *in your answer booklet*, draw a structural formula for ethanoic acid. [1]
-

Base your answers to questions 64 and 65 on the information below.

A solution is made by completely dissolving 90. grams of $\text{KNO}_3(\text{s})$ in 100. grams of water in a beaker. The temperature of this solution is 65°C .

- 64 Describe the effect on the solubility of $\text{KNO}_3(\text{s})$ in this solution when the pressure on the solution increases. [1]
- 65 Determine the total mass of $\text{KNO}_3(\text{s})$ that settles to the bottom of the beaker when the original solution is cooled to 15°C . [1]
-

Part C

Answer all questions in this part.

Directions (66–83): 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 through 68 on the information below.

The compound 1,2-ethanediol can be mixed with water. This mixture is added to automobile radiators as an engine coolant. The cooling system of a small van contains 6690 grams of 1,2-ethanediol. Some properties of water and 1,2-ethanediol are given in the table below.

Properties of Water and 1,2-ethanediol

Property	Water (H ₂ O)	1,2-ethanediol (CH ₂ OHCH ₂ OH)
gram-formula mass (g/mol)	18.0	62.0
boiling point at standard pressure (°C)	100.0	197.2

- 66 Identify the class of organic compounds to which 1,2-ethanediol belongs. [1]
- 67 State, in terms of molecular polarity, why 1,2-ethanediol is soluble in water. [1]
- 68 In the space *in your answer booklet*, calculate the total number of moles of 1, 2-ethanediol in the small van's cooling system. Your response must include *both* a correct numerical setup and the calculated result. [2]
-

Base your answers to questions 69 through 71 on the information below.

“Hand Blasters” is a toy that consists of a set of two ceramic balls, each coated with a mixture of sulfur and potassium chlorate, KClO₃. When the two balls are struck together, a loud popping noise is produced as sulfur and potassium chlorate react with each other.

- 69 Balance the equation *in your answer booklet* for the “Hand Blaster” reaction, using the smallest whole-number coefficients. [1]
- 70 Identify *one* source of the activation energy for this reaction. [1]
- 71 Determine the oxidation number of chlorine in the reactant that contains chlorine. [1]
-

Base your answers to questions 72 through 74 on the information below.

A laboratory worker filled a bottle with a hydrochloric acid solution. Another bottle was filled with methanol, while a third bottle was filled with a sodium hydroxide solution. However, the worker neglected to label each bottle. After a few days, the worker could not remember which liquid was in each bottle.

The worker needed to identify the liquid in each bottle. The bottles were labeled *A*, *B*, and *C*. Using materials found in the lab (indicators, conductivity apparatus, and pieces of Mg metal), the worker tested samples of liquid from each bottle. The test results are shown in the table below.

Table of Tests and Results

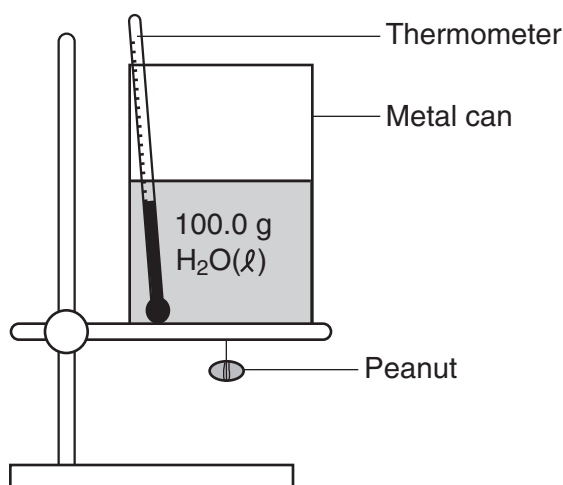
Test	Test Results		
	Bottle A	Bottle B	Bottle C
methyl orange indicator	yellow	yellow	yellow
bromthymol blue indicator	blue	green	yellow
electrical conductivity	conductor	nonconductor	conductor
reactivity with Mg metal	no reaction	no reaction	reaction

- 72 Using the test results, state how the worker differentiated the bottle that contained methanol from the other two bottles. [1]
- 73 The worker concluded that bottle *C* contained hydrochloric acid. Identify *one* test and state the corresponding test result that supports this conclusion. [1]
- 74 Explain, in terms of pH, why the methyl orange indicator test results were the same for each of the three liquids. [1]
-

Base your answers to questions 75 and 76 on the information below.

A student performed an experiment to determine the total amount of energy stored in a peanut. The accepted value for the energy content of a peanut is 30.2 kilojoules per gram.

The student measured 100.0 grams of water into a metal can and placed the can on a ring stand, as shown in the diagram below. The peanut was attached to a wire suspended under the can. The initial temperature of the water was recorded as 22.0°C. The peanut was ignited and allowed to burn. When the peanut finished burning, the final water temperature was recorded as 57.0°C. The student's experimental value for the energy content of this peanut was 25.9 kilojoules per gram.

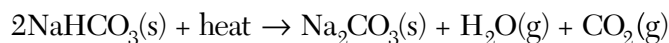


75 In the space *in your answer booklet*, calculate the total amount of heat absorbed by the water. Your response must include *both* a correct numerical setup and the calculated result. [2]

76 Determine the student's percent error for the energy content of this peanut. [1]

Base your answers to questions 77 through 79 on the information below.

Some dry chemicals can be used to put out forest fires. One of these chemicals is NaHCO_3 . When $\text{NaHCO}_3(\text{s})$ is heated, one of the products is $\text{CO}_2(\text{g})$, as shown in the balanced equation below.



77 In the space *in your answer booklet*, show a correct numerical setup for calculating the percent composition by mass of carbon in the product Na_2CO_3 . [1]

78 Identify the type of chemical reaction represented by this equation. [1]

79 Determine the total number of moles of $\text{CO}_2(\text{g})$ produced when 7.0 moles of $\text{NaHCO}_3(\text{s})$ is completely reacted. [1]

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

In an investigation, a dripless wax candle is massed and then lighted. As the candle burns, a small amount of liquid wax forms near the flame. After 10 minutes, the candle's flame is extinguished and the candle is allowed to cool. The cooled candle is massed.

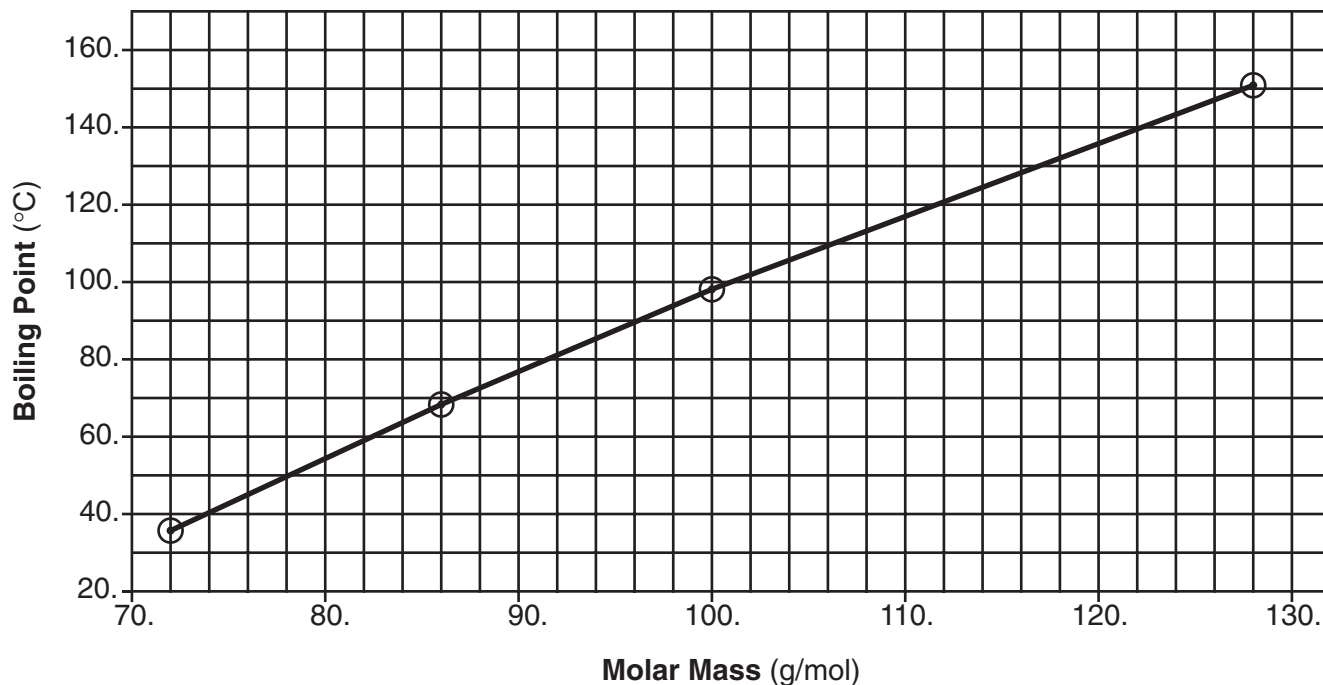
80 Identify *one* physical change that takes place in this investigation. [1]

81 State *one* observation that indicates a chemical change has occurred in this investigation. [1]

Base your answers to questions 82 and 83 on the information below.

The graph below shows the relationship between boiling point and molar mass at standard pressure for pentane, hexane, heptane, and nonane.

Boiling Point Versus Molar Mass of Some Alkanes



82 Octane has a molar mass of 114 grams per mole. According to this graph, what is the boiling point of octane at standard pressure? [1]

83 State the relationship between molar mass and the strength of intermolecular forces for the selected alkanes. [1]

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The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Thursday, January 24, 2008 — 1:15 to 4:15 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

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