XIX. Chemistry, High School

High School Chemistry Test

The spring 2007 high school MCAS Chemistry test was based on learning standards in the Chemistry content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2006). These learning standards appear on pages 69–73 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department Web site at www.doe.mass.edu/frameworks/current.html.

In *Test Item Analysis Reports* and on the Subject Area Subscore pages of the MCAS *School Reports* and *District Reports*, Chemistry test results are reported under the following four MCAS reporting categories:

- Atomic Structure and Periodicity
- Bonding and Reactions
- Properties of Matter and Thermochemistry
- Solutions, Equilibrium, and Acid-Base Theory

Test Sessions

The MCAS high school Chemistry test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

Each student taking the high school Chemistry test was provided with a Chemistry Formula and Constants Sheet/Periodic Table of the Elements. Copies of both sides of this formula sheet follow the final question in this chapter.

Each student also had sole access to a calculator with at least four functions and a square-root key.

The use of bilingual word-to-word dictionaries was allowed for current and former limited English proficient students only, during both Chemistry test sessions. No other reference tools or materials were allowed.

Cross-Reference Information

The table at the conclusion of this chapter indicates each item's reporting category and the *Framework* learning standard it assesses. The correct answers for multiple-choice questions are also displayed in the table.

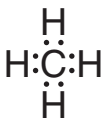
Chemistry

Session 1

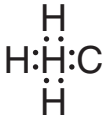
DIRECTIONS

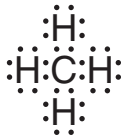
This session contains twenty-three multiple-choice questions and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

1 Which of the following Lewis dot structures represents the compound methane (CH_4)?

A. 

B. 

C. 

D. 

2 Which of the following molecules has the same empirical formula as glucose ($C_6H_{12}O_6$)?

A. butane (C_4H_{10})

B. ethanoic acid ($C_2H_4O_2$)

C. propene (C_3H_6)

D. sucrose ($C_{12}H_{22}O_{11}$)

3 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ is the electron configuration for which element?

A. aluminum (Al)

B. argon (Ar)

C. potassium (K)

D. sodium (Na)

4 What is the mass of one mole of helium gas?

A. 2 g

B. 4 g

C. 8 g

D. 22 g

5 Which of the following correctly describes molecules of two different gases if they are at the same temperature and pressure?

A. They must have the same mass.

B. They must have the same velocity.

C. They must have the same average kinetic energy.

D. They must have the same average potential energy.

6 Aluminum reacts with oxygen gas to form aluminum oxide, as shown in the reaction below.

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

How many grams of aluminum are needed to completely react with 192 g of oxygen gas?

A. 27.0 g

B. 102 g

C. 216 g

D. 432 g

7 The table below gives information about four aqueous solutions of sodium nitrate ($NaNO_3$).

Beaker	Concentration of $NaNO_3$ (%)	Temperature (°C)
1	20	0
2	20	40
3	2	80
4	2	100

In which beaker will an additional 10 g of sodium nitrate ($NaNO_3$) dissolve at the **slowest** rate?

A. 1

B. 2

C. 3

D. 4

8 The equation below shows the radioactive decay of thorium (Th).

$$^{232}_{90}\text{Th} \rightarrow {}^{228}_{88}\text{Ra} + \boxed{\text{Radiation}}$$

Which of the following particles is released in this reaction?

A. alpha ($^{4}_{2}\text{He}$)

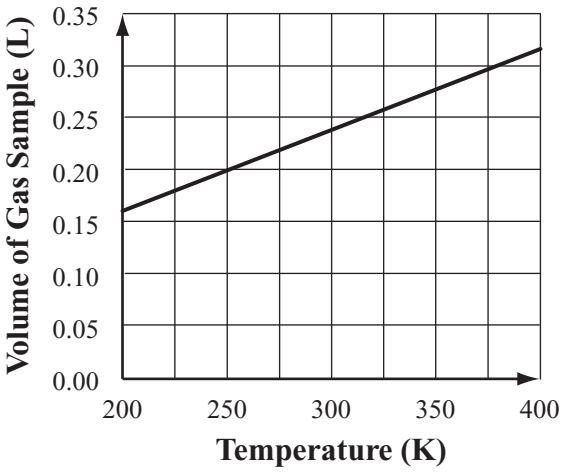
B. beta ($^{0}_{-1}e$)

C. neutron ($^{1}_{0}n$)

D. proton ($^{1}_{1}\text{H}$)

9 Assuming pressure is held constant, which of the following graphs shows how the volume of an ideal gas changes with temperature?

A.



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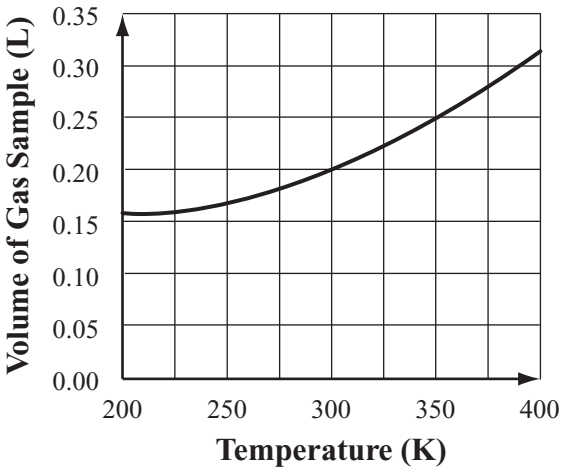
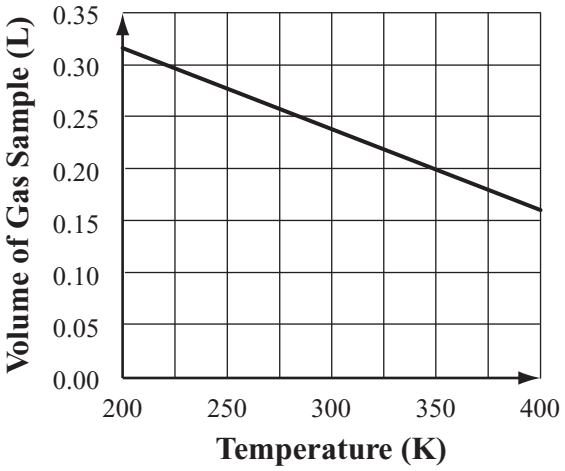
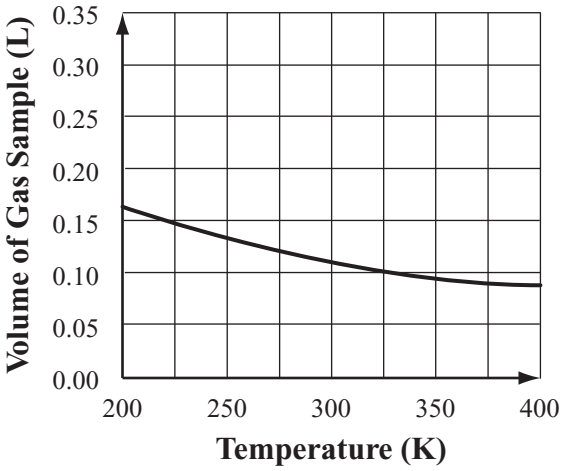


B.



D.



10 A solution that contains **less** solute than it can hold at a given temperature is

A. disassociated.

B. saturated.

C. supersaturated.

D. unsaturated.

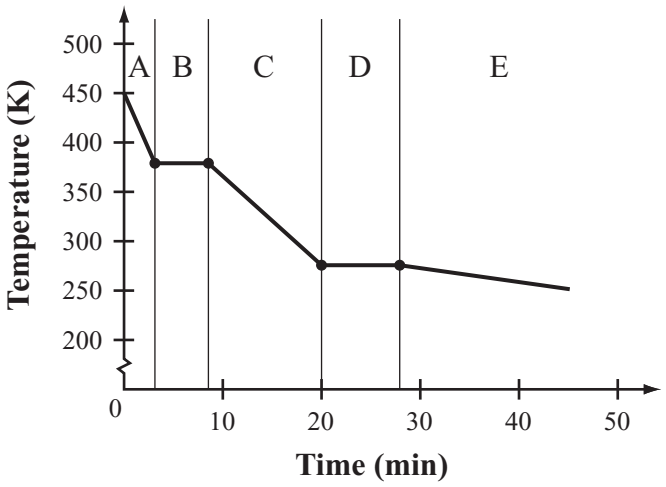
Question 11 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 11 in the space provided in your Student Answer Booklet.

11 The temperature of an unknown substance was measured as it cooled. The temperature of the substance over time was graphed and the graph was divided into five different zones, as shown below. In zone A, the substance was a gas.

Cooling Curve of an Unknown Substance



Compare what happened at the particle level in **three** of the four remaining zones: B, C, D, and E.

For **each** zone you choose, discuss all of the following:

- energy of the particles
- motion of the particles
- arrangement of the particles
- state(s) of matter present

Mark your answers to multiple-choice questions 12 through 24 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

12 The atomic number of an element indicates which of the following?

A. the number of neutrons in the atom
B. the number of protons in the atom
C. the sum of the neutrons and protons in the atom
D. the sum of the protons and electrons in the atom

13 The table below shows some information for four different elements.

Element	Classification	Density (g/cm^3)
barium (Ba)	metal	3.6
beryllium (Be)	metal	1.8
chromium (Cr)	metal	7.2
phosphorus (P)	nonmetal	1.8

A cube of an unknown element has a shiny, silvery color. The side of the cube measures 2.0 cm and the cube has a mass of 14.56 g.

Based on the information in the table, which element makes up the cube?

A. barium
B. beryllium
C. chromium
D. phosphorus

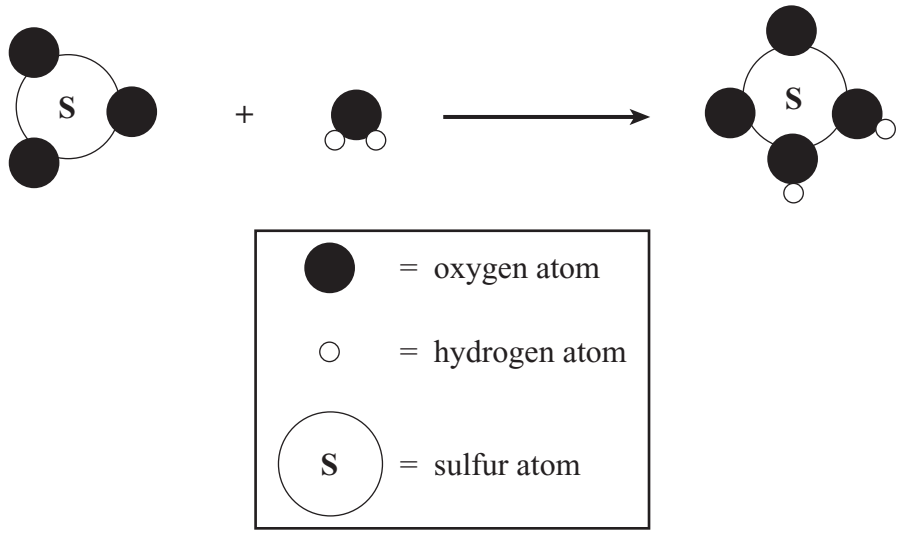
14 What is the percent mass oxygen in acetone (C_3H_6O)?

A. 1.00%
B. 10.3%
C. 27.6%
D. 62.0%

15 Which of the following is **not** true of a sample of gas as it is heated in a rigid, closed container?

A. The pressure of the molecules increases.
B. The average speed of the molecules increases.
C. The average distance between molecules increases.
D. The number of collisions between molecules increases.

16 The figure below represents a reaction.



What type of reaction is shown?

A. synthesis
B. decomposition
C. single displacement
D. double displacement

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17 The density of a gas is 1.35 g/L at standard temperature and pressure (STP). What is the molar mass of the gas at STP?

A. 0.0603 g/mol
B. 6.02 g/mol
C. 22.4 g/mol
D. 30.2 g/mol

18 The equation below shows ammonia dissolving in water.

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

Why is water considered an acid when ammonia is dissolved in it?

A. Water acts as a proton donor.
B. Water acts as a proton acceptor.
C. Water contains hydrogen atoms.
D. Water has a 2:1 ratio of hydrogen to oxygen.

19 How many atoms are in a 12.0 g sample of lithium?

A. 1.74×10^{23} atoms

B. 6.02×10^{23} atoms

C. 1.04×10^{24} atoms

D. 7.24×10^{24} atoms

20 The table below contains data for water samples from four sources.

Analysis of Water Samples

Source of Water	Sample Volume (mL)	pH
Rain	5	5.7
Creek	20	7.9
Pool	10	7.4
Faucet	20	6.8

Nancy analyzed water samples from several sources: rainfall, a nearby creek, a swimming pool, and her kitchen faucet. She recorded her data in the table.

Which sample was **most** acidic?

A. rain

B. creek

C. pool

D. faucet

21 An equation for an equilibrium reaction is shown below.

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g) + 41.7\ kJ$$

Which of the following changes in reaction conditions will **not** shift the equilibrium of the system?

A. an increase in the pressure
B. an increase in the temperature
C. a decrease in the SO_3 concentration
D. a decrease in the NO_2 concentration

22 The three main types of nuclear radiation are alpha, beta, and gamma. Which of the following lists these types of radiation from highest penetrating power to lowest penetrating power?

A. alpha, gamma, beta
B. beta, alpha, gamma
C. beta, gamma, alpha
D. gamma, beta, alpha

23 Water cools from 2°C to −2°C. During this time, what happens to the motion of the molecules?

A. The motion of the molecules stops.
B. The motion of the molecules increases.
C. The motion of the molecules decreases.
D. The motion of the molecules remains the same.

24 Which of the following elements has characteristics of some metals and also of some nonmetals?

A. antimony ($_{51}Sb$)
B. calcium ($_{20}Ca$)
C. sulfur ($_{16}S$)
D. zinc ($_{30}Zn$)

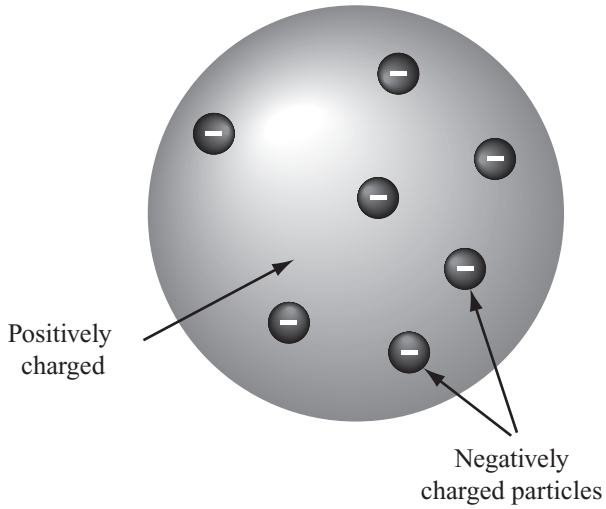
Questions 25 and 26 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 25 in the space provided in your Student Answer Booklet.

25 An early model of the atom, shown below, incorrectly described the structure of the atom as an area of positive charges with small, negatively charged particles inside.

The Plum Pudding Model of an Atom



Compare a currently accepted model of the atom with this plum pudding model. Include information about (1) the types of particles, (2) their charges, and (3) their locations for each model.

Write your answer to question 26 in the space provided in your Student Answer Booklet.

26 Magnesium oxide, MgO(s), is an ionic compound. Water, $H_2O(l)$, is a covalent compound.

a. Explain how atoms are held together in both ionic and covalent compounds.

The bonding of atoms in a compound usually makes them more stable than atoms that exist by themselves.

b. Choose one of the given compounds, MgO(s) or $H_2O(l)$, and explain in detail how its atoms bond to form a stable compound. You may use a diagram in your response.

Chemistry
SESSION 2

DIRECTIONS

This session contains seventeen multiple-choice questions and two open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

27 Which of the following explains why saltwater is considered a mixture?

A. It is composed of one element.

B. It is composed of one compound.

C. It is composed of two or more substances and has new chemical properties.

D. It is composed of two or more substances that retain their own chemical properties.

28 The table below contains a list of properties for an unidentified element, X.

Physical Characteristics	Very soft with silvery-white luster when cut
Reactivity	Ignites in air and reacts violently with cold H_2O
Some Common Compounds	XCl, X_2SO_4, X_3PO_4, XOH, X_2O
Melting Point (°C)	39.1
Boiling Point (°C)	688

Based on the properties in the table, to which of the following groups from the periodic table does element X **most likely** belong?

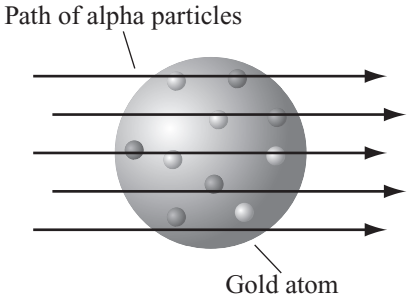
A. 1 (1A)

B. 2 (2A)

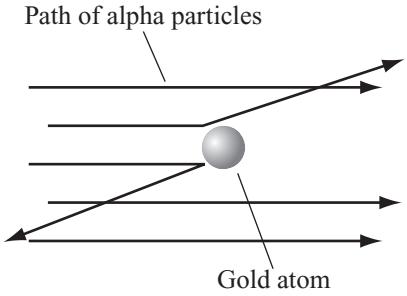
C. 14 (4A)

D. 16 (6A)

29 Ernest Rutherford performed an experiment in which he shot alpha particles through a thin layer of gold foil. He predicted that the alpha particles would travel straight through the gold atoms, as shown below.



However, Rutherford observed that although most of the alpha particles passed straight through the foil, a few alpha particles were deflected, as shown below.



Which of the following statements about the atom did Rutherford's experiment support?

A. An atom contains protons, neutrons, and electrons.

B. An atom's nucleus is small and has a positive charge.

C. Electrons follow a predictable path around the nucleus.

D. Different isotopes of an element have different masses.

30 Which of the following chemical equations is balanced correctly?

A. $C_6H_6 + O_2 \rightarrow 2CO_2 + 3H_2O$

B. $CS_2 + 3Cl_2 \rightarrow CCl_4 + S_2Cl_2$

C. $B_2O_3 + 2C \rightarrow B_4C + CO$

D. $Cl_2 + NaI \rightarrow 2NaCl + I_2$

31 Under certain conditions, solid magnesium (Mg) and solid sulfur (S) can combine and form magnesium sulfide (MgS). The oxidation-reduction reaction is shown below.

$$Mg(s) + S(s) \rightarrow MgS(s)$$

Which of the following is the oxidation number for Mg in MgS in this reaction?

A. $+1$

B. -1

C. $+2$

D. -2

Question 32 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 32 in the space provided in your Student Answer Booklet.

32 The equation below represents the reaction of water and oxygen to produce hydrogen peroxide (H_2O_2). The equation shows the reaction to be at equilibrium.

$$2H_2O(g) + O_2(g) + \text{heat} \rightleftharpoons 2H_2O_2(g)$$

Describe **two** ways to shift the equilibrium to the right in order to increase the amount of H_2O_2 produced. Explain your reasoning.

Mark your answers to multiple-choice questions 33 through 38 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

33 Which of the following is the formula for ammonium hydroxide?

A. Al_2O_3
B. AmO_2
C. NH_3OH
D. NH_4OH

34 A student adds 68.4 g of sucrose ($C_{12}H_{22}O_{11}$) to 750 mL of 20°C water. She stirs the solution until all of the sucrose crystals dissolve. She then transfers the solution to a volumetric flask and fills it to the 1.00 L mark with 20°C water.

What is the molarity of the sucrose solution the student prepared?

A. 0.20 M
B. 0.70 M
C. 1.0 M
D. 6.8 M

35 The table below shows some characteristics of four substances at 1 atm pressure.

Substance	Color	Melting Point (°C)	Boiling Point (°C)
Bromine	red-brown	–7	59
Chlorine	green-yellow	–101	–34
Ethanol	colorless	–117	78
Mercury	silver-white	–39	357

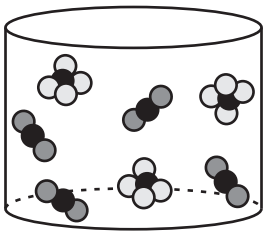
Which of the following substances is a liquid at temperatures ranging from −50°C to 0°C?

A. bromine
B. chlorine
C. ethanol
D. mercury

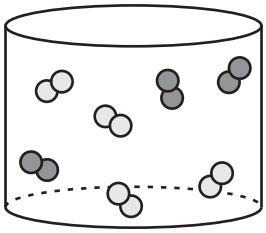
36 In the following diagrams, the spheres represent particles. Different shadings represent different particles.

Which of the following contains only one pure substance?

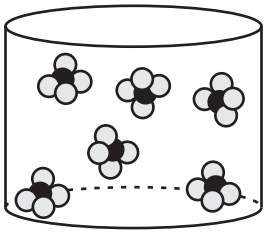
A.



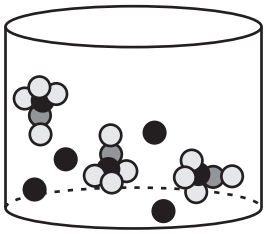
B.



C.



D.



37 Nuclear fusion occurs in the core of a star when deuterium and tritium react. The equation below represents this fusion reaction.

$$^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}n$$

Which of the following **best** explains why a large amount of energy is released in this reaction?

A. The hydrogen converts the light into energy.

B. Some of the reactant mass is converted into energy.

C. All of the hydrogen isotopes undergo radioactive decay.

D. The temperature of the products is lower than that of the reactants.

38 An unknown metal, X, combines with nitrogen to form the compound XN. Metal X also combines with oxygen to produce the compound X_2O_3.

Metal X is **most likely** which of the following elements?

A. $_{3}\mathrm{Li}$

B. $_{12}\mathrm{Mg}$

C. $_{31}\mathrm{Ga}$

D. $_{50}\mathrm{Sn}$

Question 39 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 39 in the space provided in your Student Answer Booklet.

39 Propane (C_3H_8) burns in oxygen to produce carbon dioxide and water.

a. Write a balanced chemical equation for this reaction.

b. If 11.0 g of propane gas is burned completely, 33.0 g of carbon dioxide and 18.0 g of water are produced. Determine the mass of oxygen consumed. Show your calculations and include units in your answer.

Mark your answers to multiple-choice questions 40 through 45 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

40 A 1.00 kg sample of water (H_2O) contains 0.11 kg of hydrogen (H) and 0.89 kg of oxygen (O). According to the law of constant composition, how much hydrogen and oxygen would a 1.5 kg sample of water contain?

A. 0.11 kg H and 0.89 kg O

B. 0.17 kg H and 1.34 kg O

C. 0.22 kg H and 1.78 kg O

D. 1.34 kg H and 0.17 kg O

41 When stirred in 30°C water, 5 g of powdered potassium bromide, KBr, dissolves faster than 5 g of large crystals of potassium bromide. Which of the following best explains why the powdered KBr dissolves faster?

A. Powdered potassium bromide exposes more surface area to water molecules than large crystals of potassium bromide.

B. Potassium ions and bromide ions in the powder are smaller than potassium ions and bromide ions in the large crystals.

C. Fewer potassium ions and bromide ions have been separated from each other in the powder than in the crystals.

D. Powdered potassium bromide is less dense than large crystals of potassium bromide.

42 Which of the following is an example of a physical change?

A. Iron exposed to air produces rust.

B. Hydrogen combined with oxygen forms water.

C. Sulfur combined with oxygen produces sulfur dioxide.

D. Liquid nitrogen exposed to air becomes nitrogen gas.

43 Which of the following trends in the periodic table should be expected as the atomic number of the halogens increases from fluorine (F) to iodine (I)?

A. Atomic radius decreases.

B. Electronegativity decreases.

C. Atomic mass decreases.

D. Electron number decreases.

44 Which of the following statements describes the elements in family 16 of the periodic table?

A. They have six valence electrons.

B. They are all gases at room temperature.

C. They exist commonly as cations in nature.

D. They combine easily with elements in family 17.

45 What is the volume of one mole of hydrogen gas (H_2) at standard temperature and pressure (STP)?

A. 1.0 L

B. 2.0 L

C. 22.4 L

D. 44.8 L

Massachusetts Comprehensive Assessment System
Chemistry Formula and Constants Sheet

Common Polyatomic Ions

Ion	Ionic Formula
Ammonium	NH_4^+
Carbonate	CO_3^{2-}
Hydroxide	OH^-
Nitrate	NO_3^-
Phosphate	PO_4^{3-}
Sulfate	SO_4^{2-}

Combined Gas Law: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Ideal Gas Law: $PV = nRT$

Absolute Temperature Conversion: $K = °C + 273$

Moles of Solute: $M_1V_1 = M_2V_2$

Definition of pH: $pH = -\log[H_3O^+] = -\log[H^+]$

Molar Volume of Ideal Gas at STP: 22.4 L/mol

Ideal Gas Constant: $R = 0.0821\ L \cdot atm/mol \cdot K = 8.31\ L \cdot kPa/mol \cdot K$

Avogadro's Number: 6.02×10^{23} particles/mol

STP: 1 atm (101.3 kPa), 273 K (0°C)

Nuclear Symbols

Name	Symbol
Alpha particle	α or ${}_2^4He$
Beta particle	β or ${}_{-1}^0e$
Gamma ray	γ
Neutron	${}_0^1n$

MASSACHUSETTS DEPARTMENT OF EDUCATION
MCAS
MASSACHUSETTS COMPREHENSIVE ASSESSMENT SYSTEM

Massachusetts Comprehensive Assessment System

Periodic Table of the Elements

Period	Group (Family) 1A / 1	2A / 2	3B / 3	4B / 4	5B / 5	6B / 6	7B / 7	8B / 8	8B / 9	8B / 10	1B / 11	2B / 12	3A / 13	4A / 14	5A / 15	6A / 16	7A / 17	8A / 18
1	1.00794 H 1 Hydrogen																	4.00260 He 2 Helium
2	6.941 Li 3 Lithium	9.01218 Be 4 Beryllium											10.81 B 5 Boron	12.0111 C 6 Carbon	14.0067 N 7 Nitrogen	15.9994 O 8 Oxygen	18.998403 F 9 Fluorine	20.179 Ne 10 Neon
3	22.98977 Na 11 Sodium	24.305 Mg 12 Magnesium											26.98154 Al 13 Aluminum	28.0855 Si 14 Silicon	30.97376 P 15 Phosphorus	32.06 S 16 Sulfur	35.453 Cl 17 Chlorine	39.948 Ar 18 Argon
4	39.0983 K 19 Potassium	40.08 Ca 20 Calcium	44.9559 Sc 21 Scandium	47.88 Ti 22 Titanium	50.9415 V 23 Vanadium	51.996 Cr 24 Chromium	54.9380 Mn 25 Manganese	55.847 Fe 26 Iron	58.9332 Co 27 Cobalt	58.69 Ni 28 Nickel	63.546 Cu 29 Copper	65.39 Zn 30 Zinc	69.72 Ga 31 Gallium	72.59 Ge 32 Germanium	74.9216 As 33 Arsenic	78.96 Se 34 Selenium	79.904 Br 35 Bromine	83.80 Kr 36 Krypton
5	85.4678 Rb 37 Rubidium	87.62 Sr 38 Strontium	88.9059 Y 39 Yttrium	91.224 Zr 40 Zirconium	92.9064 Nb 41 Niobium	95.94 Mo 42 Molybdenum	(98) Tc 43 Technetium	101.07 Ru 44 Ruthenium	102.906 Rh 45 Rhodium	106.42 Pd 46 Palladium	107.868 Ag 47 Silver	112.41 Cd 48 Cadmium	114.82 In 49 Indium	118.71 Sn 50 Tin	121.75 Sb 51 Antimony	127.60 Te 52 Tellurium	126.905 I 53 Iodine	131.29 Xe 54 Xenon
6	132.905 Cs 55 Cesium	137.33 Ba 56 Barium	138.906 La 57 Lanthanum	178.49 Hf 72 Hafnium	180.948 Ta 73 Tantalum	183.85 W 74 Tungsten	186.207 Re 75 Rhenium	190.2 Os 76 Osmium	192.22 Ir 77 Iridium	195.08 Pt 78 Platinum	196.967 Au 79 Gold	200.59 Hg 80 Mercury	204.383 Tl 81 Thallium	207.2 Pb 82 Lead	208.980 Bi 83 Bismuth	(209) Po 84 Polonium	(210) At 85 Astatine	(222) Rn 86 Radon
7	(223) Fr 87 Francium	226.025 Ra 88 Radium	227.028 Ac 89 Actinium	(261) Rf* 104 Rutherfordium	(262) Db 105 Dubnium	(263) Sg 106 Seaborgium	(262) Bh 107 Bohrium	(265) Hs 108 Hassium	(266?) Mt 109 Meitnerium	(269?) 110	111	112	113	114	115	116	117	118

Mass numbers in parentheses are those of the most stable or most common isotope.

Lanthanide Series	140.12 Ce 58 Cerium	140.908 Pr 59 Praseodymium	144.24 Nd 60 Neodymium	(145) Pm 61 Promethium	150.36 Sm 62 Samarium	151.96 Eu 63 Europium	157.25 Gd 64 Gadolinium	158.925 Tb 65 Terbium	162.50 Dy 66 Dysprosium	164.930 Ho 67 Holmium	167.26 Er 68 Erbium	168.934 Tm 69 Thulium	173.04 Yb 70 Ytterbium	174.967 Lu 71 Lutetium
Actinide Series	232.038 Th 90 Thorium	231.036 Pa 91 Protactinium	238.029 U 92 Uranium	237.048 Np 93 Neptunium	(244) Pu 94 Plutonium	(243) Am 95 Americium	(247) Cm 96 Curium	(247) Bk 97 Berkelium	(251) Cf 98 Californium	(252) Es 99 Einsteinium	(257) Fm 100 Fermium	(258) Md 101 Mendelevium	(259) No 102 Nobelium	(260) Lr 103 Lawrencium

High School Chemistry
Spring 2007 Released Items:
Reporting Categories, Standards, and Correct Answers

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	487	*Bonding and Reactions*	4.2	A
2	487	*Bonding and Reactions*	5.4	B
3	487	*Atomic Structure and Periodicity*	2.4	C
4	487	*Bonding and Reactions*	5.3	B
5	488	*Properties of Matter and Thermochemistry*	6.3	C
6	488	*Bonding and Reactions*	5.5	C
7	489	*Solutions, Equilibrium, and Acid-Base Theory*	7.3	A
8	489	*Atomic Structure and Periodicity*	2.6	A
9	490	*Properties of Matter and Thermochemistry*	6.1	A
10	490	*Solutions, Equilibrium, and Acid-Base Theory*	7.1	D
11	491	*Properties of Matter and Thermochemistry*	1.3	
12	492	*Atomic Structure and Periodicity*	3.1	B
13	492	*Properties of Matter and Thermochemistry*	1.1	B
14	492	*Bonding and Reactions*	5.4	C
15	492	*Properties of Matter and Thermochemistry*	6.3	C
16	493	*Bonding and Reactions*	5.2	A
17	493	*Properties of Matter and Thermochemistry*	6.2	D
18	493	*Solutions, Equilibrium, and Acid-Base Theory*	8.1	A
19	494	*Bonding and Reactions*	5.3	C
20	494	*Solutions, Equilibrium, and Acid-Base Theory*	8.2	A
21	495	*Solutions, Equilibrium, and Acid-Base Theory*	7.6	A
22	495	*Atomic Structure and Periodicity*	2.5	D
23	495	*Properties of Matter and Thermochemistry*	1.3	C
24	495	*Atomic Structure and Periodicity*	3.2	A
25	496	*Atomic Structure and Periodicity*	2.1	
26	497	*Bonding and Reactions*	4.1	
27	498	*Properties of Matter and Thermochemistry*	1.2	D
28	498	*Atomic Structure and Periodicity*	3.1	A
29	499	*Atomic Structure and Periodicity*	2.2	B
30	500	*Bonding and Reactions*	5.1	B
31	500	*Bonding and Reactions*	8.4	C
32	501	*Solutions, Equilibrium, and Acid-Base Theory*	7.6	
33	502	*Bonding and Reactions*	4.6	D
34	502	*Solutions, Equilibrium, and Acid-Base Theory*	7.2	A
35	502	*Properties of Matter and Thermochemistry*	1.3	C
36	503	*Properties of Matter and Thermochemistry*	1.2	C
37	503	*Atomic Structure and Periodicity*	2.7	B
38	503	*Bonding and Reactions*	4.1	C
39	504	*Bonding and Reactions*	5.1	
40	505	*Atomic Structure and Periodicity*	2.3	B
41	505	*Solutions, Equilibrium, and Acid-Base Theory*	7.3	A
42	506	*Properties of Matter and Thermochemistry*	1.1	D

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
43	506	*Atomic Structure and Periodicity*	3.4	B
44	506	*Atomic Structure and Periodicity*	3.1	A
45	506	*Properties of Matter and Thermochemistry*	6.2	C

* Answers are provided here for multiple-choice items only. Sample responses and scoring guidelines for open-response items, which are indicated by shaded cells, will be posted to the Department's Web site later this year.