XIII. Chemistry, Grade 10

Grade 10 Chemistry Pilot Test

The spring 2005 Grade 10 MCAS Chemistry Test was based on learning standards in the Chemistry content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2001). These learning standards appear on pages 63–67 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department Web site at www.doe.mass.edu/frameworks/scitech/2001/0501.pdf.

Because the Grade 10 Chemistry Test was administered as a pilot test this year, the reporting of results is limited to *Test Item Analysis Reports*. No scaled score or performance level results are available.

Test Sessions and Content Overview

The MCAS Grade 10 Chemistry Test included two separate test sessions. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

Each student taking the Grade 10 Chemistry Test was provided with a *Chemistry Formula and Constants Sheet/Periodic Table of the Elements*. Copies of both sides of this reference 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. No other reference tools or materials were allowed.

The use of bilingual word-to-word dictionaries was allowed for limited English proficient students only, during both Chemistry test sessions.

Cross-Reference Information

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

Chemistry □

DIRECTIONS
This session contains ten multiple-choice questions and one open-response question. 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 A solid cube was put into a cylinder containing four liquids with different densities as shown below.

Substance A = 1.50 g/cm^3

Substance B = 3.50 g/cm^3

Substance C = 6.0 g/cm^3

Substance D = 9.0 g/cm^3
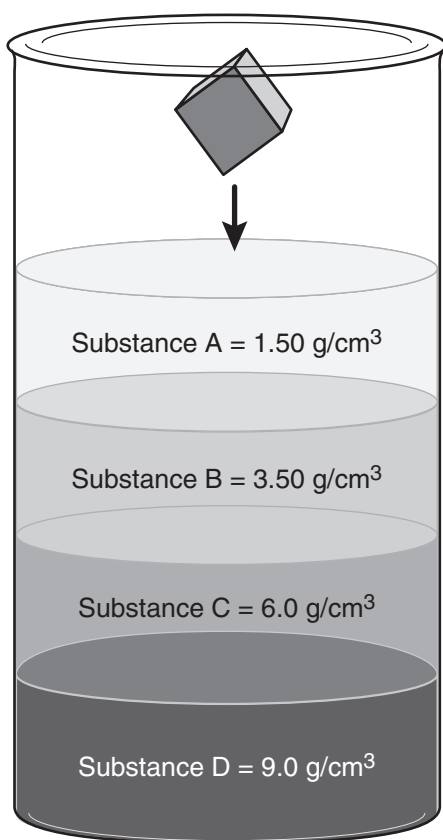
The cube fell quickly through layer A, fell slowly through layer B, and stopped upon reaching layer C. The density of the cube **most likely** lies between

A. 1.00 and 1.50 g/cm^3.

B. 1.51 and 3.50 g/cm^3.

C. 3.51 and 6.00 g/cm^3.

D. 6.00 and 9.00 g/cm^3.

2 The correct name for an aqueous solution of HCl is

A. chloric acid.

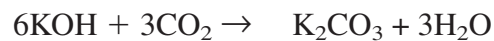B. chlorous acid.

C. hydrochloric acid.

D. hydrogen chloride.

3 The solubility of a substance can be described in a variety of ways. Some references may use descriptive terms for solubility, such as those in the table illustrated below.

Descriptive terms	Parts of solvent needed for 1 part solute
Very soluble	<1
Freely soluble	1–10
Soluble	10–30
Sparingly soluble	30–100
Slightly soluble	100–1,000
Very slightly soluble	1,000–10,000
Practically insoluble or insoluble	>10,000

Using the table above as a reference, what descriptive term would be used for a medication that required 4,000 mg of water to dissolve 200 mg of the drug?

A. soluble

B. slightly soluble

C. sparingly soluble
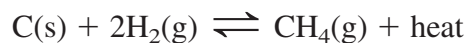
D. very slightly soluble

4 Potassium carbonate (K_2CO_3) is an important component of fertilizer. The partially balanced equation for the reaction of 6 moles of potassium hydroxide (KOH) and 3 moles of carbon dioxide (CO_2) to produce potassium carbonate and water is given below.

$6KOH + 3CO_2 \rightarrow \underline{\quad}K_2CO_3 + 3H_2O$

When this equation is balanced, what is the coefficient for potassium carbonate?

A. 2

B. 3

C. 6

D. 9

5 The figure below represents the periodic table and the location of four different elements on the table.

A certain element has a ground state electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^6$. Which letter in the diagram above represents the position of this element on the periodic table?

A. Y

B. W

C. X

D. Z

6 The equation for a chemical reaction is shown below.

$$C(s) + 2H_2(g) \rightleftharpoons CH_4(g) + heat$$

Which of the following actions will produce a shift of the reaction to the left?

A. removing CH_4 from the system

B. increasing the pressure at which the reaction is performed

C. increasing the temperature at which the reaction is performed

D. increasing the amount of H_2 used

7 A student was assigned to take water samples from a lake near his home. He measured the pH of one of the water samples to be 6.0. Which of the following **best** describes this sample of water?

A. highly acidic

B. slightly acidic

C. highly basic

D. slightly basic

Question 8 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 8 in the space provided in your Student Answer Booklet.

8   Several chemists examined a pure, unknown substance and observed and measured its physical properties. Their results are shown below.

Unknown Substance

Physical Property	Description or Value
Color	Clear and colorless
Flammability	None
Odor	Sweet, distinctive odor
Melting point	–22.9°C
Boiling point	76.74°C
Density at 20°C	1.585 g/cm^3
Water solubility at 20°C	0.08 g/100 g H_2O

Based on the data recorded in the table, answer the following.

a.□What is the physical state of this substance at room temperature? Explain how the information in the table is used to make this classification of the substance's state.

b.□The substance is unreactive in water. What will happen if 10.00 g of this substance is added to 200. g of water at 20°C and standard pressure? Explain your response.

Mark your answers to multiple-choice questions 9 through 11 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.

9 Which of the following graphs **best** represents how the average kinetic energy of molecules changes with absolute temperature?

A.

Kinetic Energy

Absolute Temperature

B.

Kinetic Energy

Absolute Temperature

C.

Kinetic Energy

Absolute Temperature

D.

Kinetic Energy

Absolute Temperature
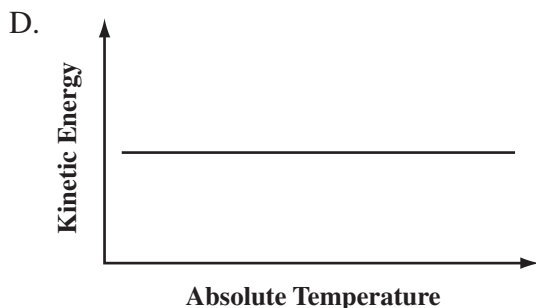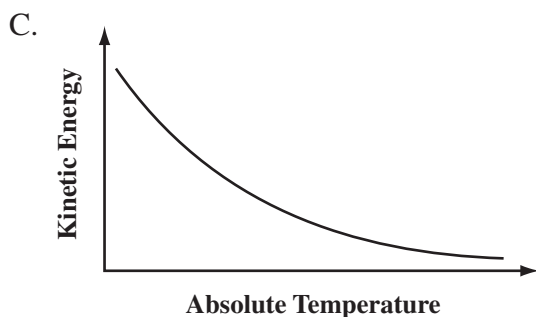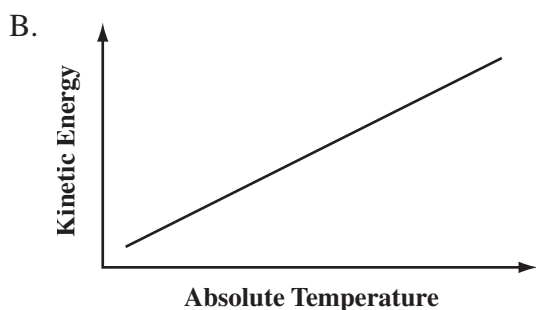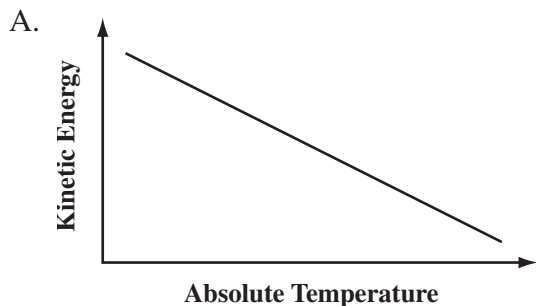
10 How many moles of oxygen atoms are present in 2 moles of $Mg_3(PO_4)_2$?

A. 4

B. 8

C. 12

D. 16

11 When elements from group 1 (1A) combine with elements from group 17 (7A), they produce compounds. Which of the following is the correct combining ratio between group 1 (1A) elements and group 17 (7A) elements?

A. 1:1

B. 1:2

C. 2:1

D. 3:2

Chemistry☐

Session 2

DIRECTIONS
This session contains ten multiple-choice questions and one open-response question. 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.

12 The illustration below shows two atoms of a fictitious element (M) forming a diatomic molecule.
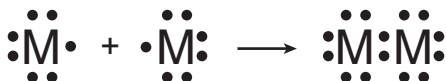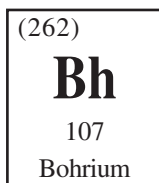

What type of bonding occurs between these two atoms?

A. covalent

B. ionic

C. nuclear

D. polar

13 A student pours mineral salts into a bottle of cold water. Which of the following **best** explains why shaking the bottle will affect the dissolving rate of the salt?
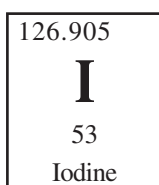
A. Shaking exposes the salts to the solvent more quickly.

B. Shaking helps more water to evaporate.

C. Shaking causes more ions to precipitate out of solution.

D. Shaking equalizes the water temperature.

14 Which of the following elements can form an anion that contains 54 electrons, 74 neutrons, and 53 protons?
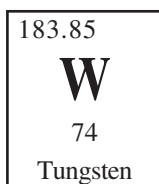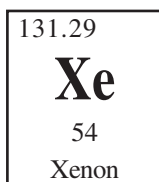
A.

| (262) |
| **Bh** |
| 107 |
| Bohrium |

B.

| 126.905 |
| **I** |
| 53 |
| Iodine |

C.

| 183.85 |
| **W** |
| 74 |
| Tungsten |

D.

| 131.29 |
| **Xe** |
| 54 |
| Xenon |

15   The table below shows pH values of some foods.

pH Values of Some Important Foods

Vegetables	pH	Citrus	pH	Dairy/Egg	pH	Starches	pH
Asparagus	5.6	Grapefruit	3.2	Butter	6.2	Bread (white)	5.5
Beans	5.5	Lemons	2.3	Cheese	5.6	Corn	6.2
Peas	6.1	Limes	1.9	Eggs (fresh)	7.8	Crackers	7.5
Spinach	5.4	Oranges	3.5	Milk	6.5	Potatoes	5.8

A patient has chronic indigestion due to an overproduction of stomach acid. Which foods should the patient avoid until the condition is resolved?

A. vegetables

B. citrus

C. dairy/egg

D. starches

16 A student bends a paperclip rapidly back and forth. When he touches the point where he was bending the paperclip, he finds that its temperature has increased. This indicates that the atoms in that part of the paperclip have increased in
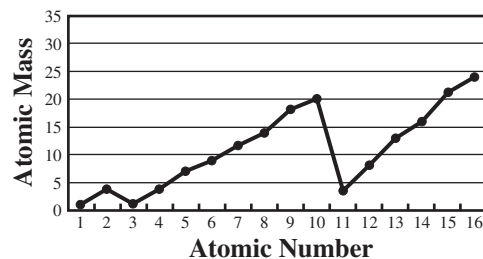
A. conductivity.

B. kinetic energy.

C. mass.

D. number.

17 Which of the following graphs **best** shows the relationship between an element's atomic mass and its atomic number?
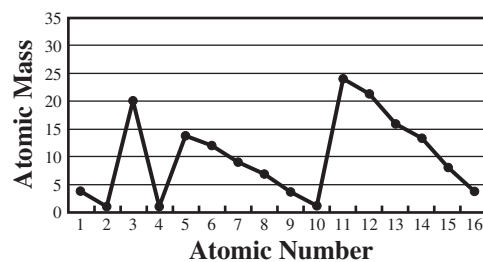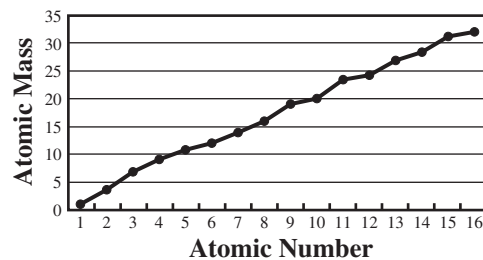
A.
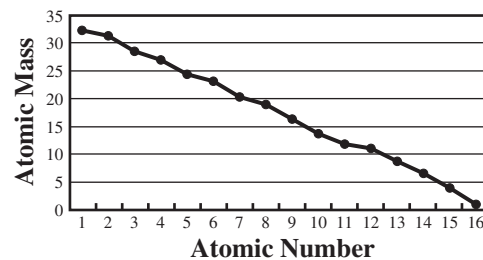
B.

C.

D.

Question 18 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 18 in the space provided in your Student Answer Booklet.

18 A student burned a sample of pure carbon in an open crucible. The carbon reacted with oxygen in the air and produced carbon dioxide.

a.☐In your Student Answer Booklet, write the balanced equation for the complete combustion of carbon.

b.☐The student observed no visible products. Why does it appear that the law of conservation of mass was violated by this reaction?

c.☐If one mole of carbon is burned, how many moles of oxygen gas will be consumed and how many moles of product should be obtained? Explain how you determined these values.

Mark your answers to multiple-choice questions 19 through 22 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.

19 A picture of a balloon is shown below.
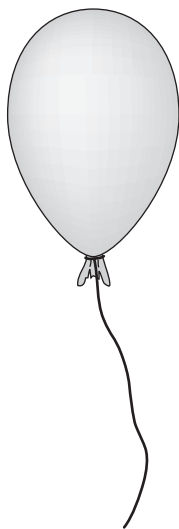
If the temperature of this balloon were to decrease suddenly, how would the balloon change?

A. Its mass would increase.

B. Its mass would decrease.

C. Its volume would increase.

D. Its volume would decrease.

20 Aluminum reacts vigorously and exothermically with copper(II) chloride. Which of the following is the balanced equation for this reaction?

A. $Al + CuCl_2 \rightarrow AlCl_3 + Cu$

B. $Al + 3CuCl_2 \rightarrow 2AlCl_3 + Cu$

C. $2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu$

D. $3Al + 2CuCl_2 \rightarrow 3AlCl_3 + 2Cu$

21 A data table and two prepared beakers are shown below.

Temperature (°C)	Solubility of KNO_3 in 100 g H_2O
10	22 g
20	33 g
30	48 g
40	65 g
50	84 g
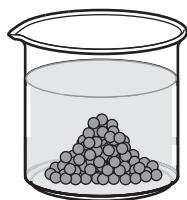
Beaker A
10 g KNO_3
100 g H_2O
10°C
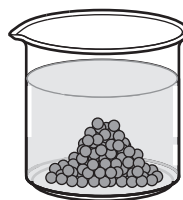
Beaker B
10 g KNO_3
100 g H_2O
50°C

Solid KNO_3 was added to each beaker. Each beaker was stirred at the same rate until all of the solid dissolved. The table shows the solubilities of KNO_3 at different temperatures. How will the rates of dissolving compare?

A. KNO_3 will dissolve faster in Beaker B because of increased surface area.

B. KNO_3 will dissolve faster in Beaker A because the water molecules are farther apart.

C. KNO_3 will dissolve faster in Beaker B because the overall kinetic energy is increased.

D. KNO_3 will dissolve at the same rate in Beaker A and Beaker B because the concentrations are the same.

22 Which of the following represents a double displacement reaction?

A. $ABC \rightarrow AB + C$

B. $A + B \rightarrow AB$

C. $AB + CD \rightarrow AD + CB$

D. $A + BC \rightarrow AC + B$
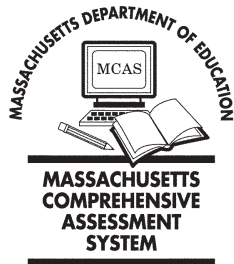
Massachusetts Comprehensive Assessment System
Chemistry Formula and Constants Sheet

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-}

Ideal Gas Law: $PV = nRT$

Absolute Temperature Conversion: $K = {}^\circ C + 273$

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

Specific Heat of Water: $c_{H_2O} = 1.00 \, cal/g \cdot {}^\circ C = 4.18 \, J/g \cdot {}^\circ C$

Mole-Volume of Ideal Gas at STP: 22.4 L at STP

Ideal Gas Constant: $R = 0.0821 \, L \cdot atm/mol \cdot K = 8.314 \, L \cdot kPa/mol \cdot K$

Avogadro's number: 6.02×10^{23}

STP: 1 atm, 0°C

Nuclear Particles

Name	Symbol
Alpha particle	α or ${}^4_2He$
Beta particle	β or ${}^{\ 0}_{-1}e$
Neutron	${}^1_0n$

Massachusetts Comprehensive Assessment System

Periodic Table of the Elements

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
1.00794 H 1 Hydrogen																	4.00260 He 2 Helium
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
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
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
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
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
(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

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

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

Grade 10 Chemistry
Spring 2005 Released Items:
Standards and Correct Answers

Item No.	Page No.	Standard	Correct Answer (MC)*
1	291	1.1	C
2	291	4.7	C
3	292	7.1	A
4	292	5.1	B
5	293	3.3	C
6	294	9.3	C
7	294	8.1	B
8	295	1.1	
9	296	6.2	B
10	296	5.3	D
11	296	4.6	A
12	297	4.1	A
13	297	7.2	A
14	298	3.2	B
15	299	8.1	B
16	300	6.2	B
17	300	3.1	D
18	301	2.2	
19	302	6.1	D
20	302	5.1	C
21	303	7.2	C
22	303	5.2	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.