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## XIII. Chemistry, Grade 10

# Grade 10 Chemistry Pilot Test

The spring 2004 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 website at [www.doe.mass.edu/frameworks/scitech/2001/0501.pdf](http://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 Grade 10 Chemistry Test contained two separate test sessions. Each session included multiple-choice and open-response questions. Common test items are shown on the following pages as they appeared in test booklets.

## Reference Materials and Tools

During Testing, 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 access to a calculator with at least four functions and a square root key.

No other reference tools or materials were allowed, with the exception of bilingual word-to-word dictionaries used by limited English proficient students.

## 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.

## **HOW TO ANSWER OPEN-RESPONSE QUESTIONS**

Be sure to

- read all parts of each question carefully.
- make each response as clear, complete, and accurate as you can.
- check your answers.

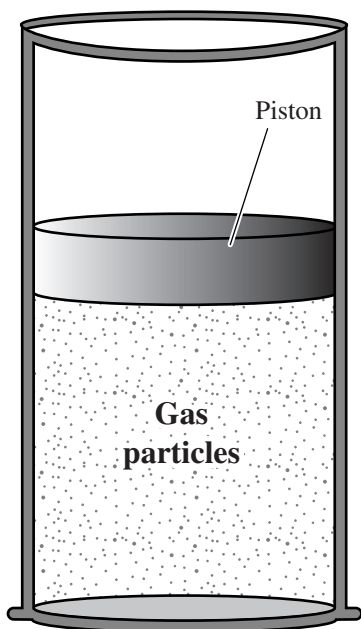
# Chemistry

## SESSION 1

### 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.

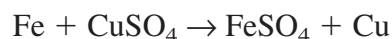
- 1 The picture below shows a gas at standard conditions in a container with a moveable piston.



According to Charles's law, what will happen to the piston when the gas is heated?

- A. The piston will move up because the gas particles get larger.
- B. There will be no change because heat will not affect the system.
- C. The piston will move up because the gas particles move faster and get farther apart.
- D. The piston will move down because the gas particles move slower and get closer together.

- 2 Copper in the compound  $\text{CuSO}_4$  can be isolated in the following reaction with iron.

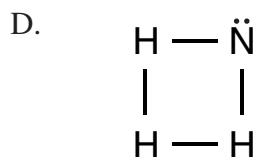
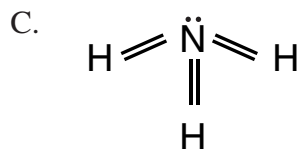
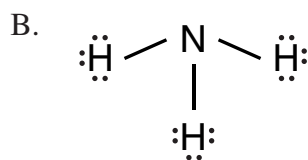
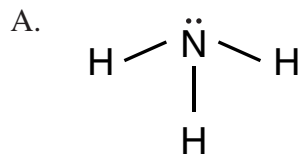


What type of reaction is shown above?

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

- 3 Which of the following elements has the highest electronegativity?
- A. B (boron)
  - B. C (carbon)
  - C. O (oxygen)
  - D. N (nitrogen)
- 4 A student heated a 10 g sample of a compound in an open container. A chemical reaction occurred. The mass of the sample was measured again and found to be less than before. Which of the following explains the change in mass of the sample?
- A. The heat caused the compound to become less dense.
  - B. The reaction gave off more heat than was added.
  - C. Some of the lighter atoms were converted to energy.
  - D. One of the reaction products was a gas.

- 5 The chemical formula for ammonia is  $\text{NH}_3$ . Which of the following is the correct Lewis electron dot structure for ammonia?



6 Which of the following represents a pair of isotopes?

- A.  $^1\text{H}$  and  $^3\text{H}$
- B.  $^{16}\text{O}^{2-}$  and  $^{19}\text{F}^{1-}$
- C.  $^{40}\text{K}$  and  $^{40}\text{Ca}$
- D.  $^{16}\text{O}^{2-}$  and  $^{32}\text{S}^{2-}$

7 The water from hot springs near the Ebeko volcano in the Pacific Ocean has a very low pH.

A low pH indicates which of the following about the water?

- A. It has no detectable  $\text{H}^+$  or  $\text{OH}^-$  ions.
- B. It has equal concentrations of  $\text{H}^+$  and  $\text{OH}^-$  ions.
- C. It has high concentrations of  $\text{H}^+$  ions.
- D. It has equal numbers of positive and negative ions.

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 A student drops a cube of sugar that has a mass of 15 g into a 2.0 L sample of water at 20°C. The student then observes the rate at which the sugar dissolves.
- Identify **two** changes that the student could make to the materials to increase the rate at which the sugar dissolves in the water.
  - Explain why **each** of these two changes would increase the rate at which the sugar dissolves in water.

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 The table below shows the physical properties of selected metals.

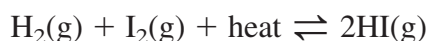
Physical Properties of Selected Metals

Metal	Molecular mass (amu)	Melting point (°C)	Boiling point (°C)	Density (g/cm <sup>3</sup> )
Bismuth	209.98	271	1560	9.80
Chromium	52.00	1857	2672	7.20
Polonium	210.05	254	962	9.40
Ruthenium	101.07	2310	3900	12.3

A cube of an unknown metal has a volume of 2.25 cm<sup>3</sup> and a mass of 16.2 g. Based on data in the table above, what is the identity of this metal?

- A. bismuth
- B. chromium
- C. polonium
- D. ruthenium

- 10 In the equilibrium process shown below, hydrogen gas and iodine gas react to form hydrogen iodide.



An increase in which of the following would shift the equilibrium to the left?

- A. amount of heat
- B. amount of I<sub>2</sub>
- C. concentration of HI
- D. concentration of H<sub>2</sub>

- 11 Limestone is a naturally occurring form of calcium carbonate. The correct formula for limestone is

- A. Ca(CO<sub>3</sub>)<sub>2</sub>.
- B. CaCO<sub>3</sub>.
- C. Ca<sub>2</sub>CO<sub>3</sub>.
- D. Ca<sub>2</sub>(CO<sub>3</sub>)<sub>2</sub>.

# Chemistry

## SESSION 2

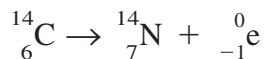
### DIRECTIONS

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 positions of copper (Cu) and carbon (C) are identified on the periodic table below.

1 <b>H</b>																	2 <b>He</b>	
3 <b>Li</b>	4 <b>Be</b>											5 <b>B</b>	6 <b>C</b>	7 <b>N</b>	8 <b>O</b>	9 <b>F</b>	10 <b>Ne</b>	
11 <b>Na</b>	12 <b>Mg</b>											13 <b>Al</b>	14 <b>Si</b>	15 <b>P</b>	16 <b>S</b>	17 <b>Cl</b>	18 <b>Ar</b>	
19 <b>K</b>	20 <b>Ca</b>	21 <b>Sc</b>	22 <b>Ti</b>	23 <b>V</b>	24 <b>Cr</b>	25 <b>Mn</b>	26 <b>Fe</b>	27 <b>Co</b>	28 <b>Ni</b>	29 <b>Cu</b>	30 <b>Zn</b>	31 <b>Ga</b>	32 <b>Ge</b>	33 <b>As</b>	34 <b>Se</b>	35 <b>Br</b>	36 <b>Kr</b>	
37 <b>Rb</b>	38 <b>Sr</b>	39 <b>Y</b>	40 <b>Zr</b>	41 <b>Nb</b>	42 <b>Mo</b>	43 <b>Tc</b>	44 <b>Ru</b>	45 <b>Rh</b>	46 <b>Pd</b>	47 <b>Ag</b>	48 <b>Cd</b>	49 <b>In</b>	50 <b>Sn</b>	51 <b>Sb</b>	52 <b>Te</b>	53 <b>I</b>	54 <b>Xe</b>	
55 <b>Cs</b>	56 <b>Ba</b>	57 <b>La</b>	72 <b>Hf</b>	73 <b>Ta</b>	74 <b>W</b>	75 <b>Re</b>	76 <b>Os</b>	77 <b>Ir</b>	78 <b>Pt</b>	79 <b>Au</b>	80 <b>Hg</b>	81 <b>Tl</b>	82 <b>Pb</b>	83 <b>Bi</b>	84 <b>Po</b>	85 <b>At</b>	86 <b>Rn</b>	
87 <b>Fr</b>	88 <b>Ra</b>	89 <b>Ac</b>	104 <b>Rf</b>	105 <b>Db</b>	106 <b>Sg</b>	107 <b>Bh</b>	108 <b>Hs</b>	109 <b>Mt</b>										
			58 <b>Ce</b>	59 <b>Pr</b>	60 <b>Nd</b>	61 <b>Pm</b>	62 <b>Sm</b>	63 <b>Eu</b>	64 <b>Gd</b>	65 <b>Tb</b>	66 <b>Dy</b>	67 <b>Ho</b>	68 <b>Er</b>	69 <b>Tm</b>	70 <b>Yb</b>	71 <b>Lu</b>		
			90 <b>Th</b>	91 <b>Pa</b>	92 <b>U</b>	93 <b>Np</b>	94 <b>Pu</b>	95 <b>Am</b>	96 <b>Cm</b>	97 <b>Bk</b>	98 <b>Cf</b>	99 <b>Es</b>	100 <b>Fm</b>	101 <b>Md</b>	102 <b>No</b>	103 <b>Lr</b>		

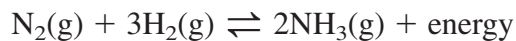
When carbon-14 decays, it emits a beta particle to produce nitrogen-14, as shown below.



When copper-67 undergoes beta decay, which of the following isotopes is produced?

- A. copper-66
- B. copper-68
- C. nickel-67
- D. zinc-67

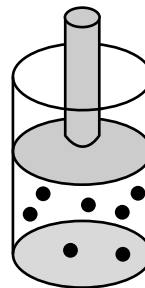
- 13 The Haber process is used to convert atmospheric nitrogen into ammonia,  $\text{NH}_3$ , a compound used in fertilizers. The reaction is shown below.



How can the equilibrium of this reaction be shifted to the right?

- A. by decreasing the mass of  $\text{N}_2$
- B. by decreasing the mass of  $\text{H}_2$
- C. by increasing the pressure on the system
- D. by increasing the volume of the system

- 14 A cylinder of gas particles is shown below.



The cylinder is fitted with a moveable piston that can be raised and lowered. Which of the following would result in an **increase** in the pressure of the gas below the piston?

- A. increasing the volume of the cylinder
- B. removing some of the gas from the cylinder
- C. decreasing the volume of the cylinder
- D. decreasing the pressure outside the cylinder

15 In potassium fluoride, the potassium atom donates an electron and the fluorine atom takes an electron. When the compound potassium fluoride is formed, which of the following are formed?

- A. covalent bonds
- B. ionic bonds
- C. magnetic forces
- D. nuclear forces

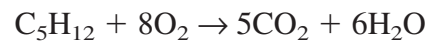
16 The table below shows the pH values of samples of substances.

Substance	pH
Rainwater	5.8
Drain cleaner	14.0
Distilled water	7.0
Soda water	3.0

According to the table, which of these substances is basic?

- A. rainwater
- B. drain cleaner
- C. distilled water
- D. soda water

17 A balanced chemical reaction is shown below.



If 3 moles of  $\text{C}_5\text{H}_{12}$  are reacted completely, how many moles of water are formed?

- A. 3
- B. 6
- C. 12
- D. 18

**Question 18 is an open-response question.**

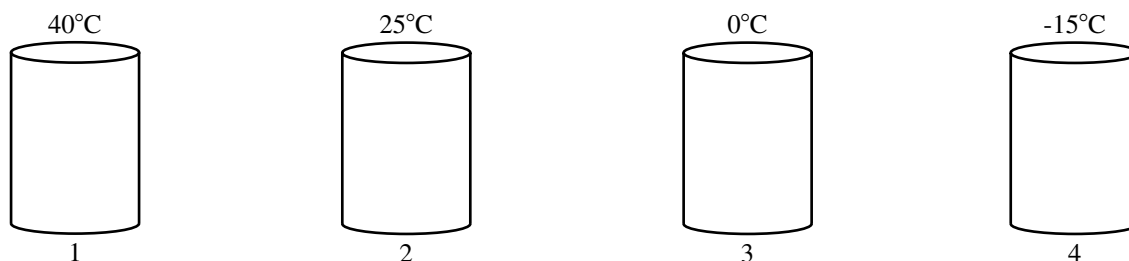
- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

**Write your answer to question 18 in the space provided in your Student Answer Booklet.**

- 18** A pot containing a few milliliters of water is placed on a hot burner. The water is boiled until no water is left in the pot.
- A frying pan is placed on a hot burner. A raw egg is taken out of its shell and placed in the frying pan until the egg white becomes solid.
- Describe the change that takes place in the water. Be sure to indicate whether the change is chemical or physical.
  
  
  
  
  
  
  
  
  
  
  - Describe the change that takes place in the egg white. Be sure to indicate whether the change is chemical or physical.

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 The illustration below shows four containers. Each container is full of helium gas at a different temperature.



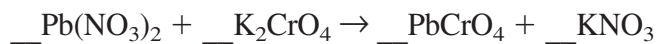
If all of the containers are closed and have a pressure of 1 atm, which container has helium particles with the **greatest** average kinetic energy?

- A. 1
- B. 2
- C. 3
- D. 4

- 20 Many laboratory preparations of solutions call for stirring the solvent while adding the solute. Which of the following is always an effect of this procedure?

- A. It decreases the reactivity of the solute.
- B. It decreases the solubility of the solute.
- C. It brings the solute and solvent rapidly into contact.
- D. It produces a double displacement reaction.

- 21 An unbalanced chemical equation is shown below.

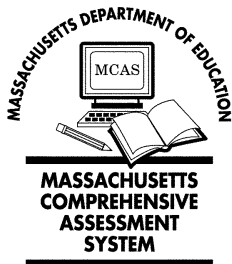


Which coefficients are needed to balance this equation?

- A. 2, 4, 4, 6
- B. 2, 4, 4, 3
- C. 1, 1, 1, 2
- D. 1, 6, 6, 2

- 22 Which of the following elements is a nonmetal?

- A. fluorine
- B. copper
- C. magnesium
- D. sodium



## Massachusetts Comprehensive Assessment System Chemistry Formula and Constants Sheet

### Common Polyatomic Ions

Ion	Ionic Formula
Ammonium	$\text{NH}_4^+$
Carbonate	$\text{CO}_3^{2-}$
Hydroxide	$\text{OH}^-$
Nitrate	$\text{NO}_3^-$
Phosphate	$\text{PO}_4^{3-}$
Sulfate	$\text{SO}_4^{2-}$

**Ideal Gas Law:**  $PV = nRT$

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

**Definition of pH:**  $\text{pH} = -\log [\text{H}_3\text{O}^+]$

**Specific Heat of Water:**  $c_{\text{H}_2\text{O}} = 1.00 \text{ cal/g} \cdot ^\circ\text{C} = 4.18 \text{ J/g} \cdot ^\circ\text{C}$

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

**Ideal Gas Constant:**  $R = 0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K} = 8.314 \text{ L} \cdot \text{kPa/mol} \cdot \text{K}$

**Avogadro's number:**  $6.02 \times 10^{23}$

**STP:** 1 atm,  $0^\circ\text{C}$

# Massachusetts Comprehensive Assessment System

## Periodic Table of the Elements

Group (Family)

1A  
1

1.00794	H	1
Hydrogen		

8A  
18

4.00260	He	2
Helium		

2A  
2

6.941	Li	3	9.01218	Be	4
Lithium		Beryllium			
22.98977	Na	11	24.305	Mg	12
Sodium		Magnesium			

3B  
3

39.0983	K	19	44.9559	Sc	21	47.88	Ti	22	50.9415	V	23	54.9380	Mn	25	58.69	Ni	28	63.546	Cu	29	65.39	Zn	30	69.72	Al	13	72.59	Si	14	74.9216	P	15	78.96	S	16	83.80	Ar	18			
Potassium		Scandium		Titanium		Vanadium		Chromium		Manganese		Iron		Cobalt		Nickel		Copper		Zinc		Gallium		Germanium		Arsenic		Selenium		Bromine		Krypton									
85.4678	Rb	37	88.9059	Y	39	91.224	Zr	40	92.9064	Nb	41	101.07	Ru	44	102.906	Rh	45	106.42	Pd	46	107.868	Ag	47	112.41	In	49	114.82	Sn	50	118.71	Sb	51	121.75	Te	52	126.905	I	53	131.29	Xe	54
Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Technetium		Ruthenium		Rhodium		Palladium		Silver		Cadmium		Indium		Tin		Antimony		Tellurium		Iodine		Xenon							

4A  
4

132.905	Cs	55	138.906	La	57	178.49	Hf	72	180.948	Ta	73	190.2	Os	76	192.22	Ir	77	195.08	Pt	78	196.967	Au	79	200.59	Hg	80	204.383	Tl	81	207.2	Pb	82	208.980	Bi	83	209	Po	84	210	Rn	86
Cesium		Barium		Lanthanum		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium		Platinum		Gold		Mercury		Thallium		Lead		Bismuth		Polonium		Astatine		Radon							
(223)	Fr	87	227.028	Ac	89	227.028	Rf*	104	(262)	Db	105	(265)	Hs	108	(268?)	Mt	109	(269?)																							
Francium		Radium		Actinium		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hassium		Meitnerium																									

5A  
5

132.905	Cs	55	138.906	La	57	178.49	Hf	72	180.948	Ta	73	190.2	Os	76	192.22	Ir	77	195.08	Pt	78	196.967	Au	79	200.59	Hg	80	204.383	Tl	81	207.2	Pb	82	208.980	Bi	83	209	Po	84	210	Rn	86
Cesium		Barium		Lanthanum		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium		Platinum		Gold		Mercury		Thallium		Lead		Bismuth		Polonium		Astatine		Radon							
(223)	Fr	87	227.028	Ac	89	227.028	Rf*	104	(262)	Db	105	(265)	Hs	108	(268?)	Mt	109	(269?)																							
Francium		Radium		Actinium		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hassium		Meitnerium																									

6A  
6

132.905	Cs	55	138.906	La	57	178.49	Hf	72	180.948	Ta	73	190.2	Os	76	192.22	Ir	77	195.08	Pt	78	196.967	Au	79	200.59	Hg	80	204.383	Tl	81	207.2	Pb	82	208.980	Bi	83	209	Po	84	210	Rn	86
Cesium		Barium		Lanthanum		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium		Platinum		Gold		Mercury		Thallium		Lead		Bismuth		Polonium		Astatine		Radon							
(223)	Fr	87	227.028	Ac	89	227.028	Rf*	104	(262)	Db	105	(265)	Hs	108	(268?)	Mt	109	(269?)																							
Francium		Radium		Actinium		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hassium		Meitnerium																									

7A  
7

132.905	Cs	55	138.906	La	57	178.49	Hf	72	180.948	Ta	73	190.2	Os	76	192.22	Ir	77	195.08	Pt	78	196.967	Au	79	200.59	Hg	80	204.383	Tl	81	207.2	Pb	82	208.980	Bi	83	209	Po	84	210	Rn	86
Cesium		Barium		Lanthanum		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium		Platinum		Gold		Mercury		Thallium		Lead		Bismuth		Polonium		Astatine		Radon							
(223)	Fr	87	227.028	Ac	89	227.028	Rf*	104	(262)	Db	105	(265)	Hs	108	(268?)	Mt	109	(269?)																							
Francium		Radium		Actinium		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hassium		Meitnerium																									

Period

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

Lanthanide Series

Actinide Series

140.12	Ce	58	140.908	Pr	59	144.24	Nd	60	150.36	Sm	62	151.96	Eu	63	157.25	Gd	64	158.925	Tb	65	162.50	Dy	66	164.930	Ho	67	167.26	Er	68	168.934	Tm	69	173.04	Yb	70	174.967	Lu	71
Cerium		Praseodymium		Neodymium		Promethium		Samarium		Europium		Gadolinium		Terbium		Dysprosium		Holmium		Erbium		Thulium		Ytterbium		Lutetium												
232.038	Th	90	231.036	Pa	91	238.029	U	92	237.048	Np	93	237.043	Am	95	247	Bk	96	247	Cm	96	247	Cf	98	251	Es	99	257	Fm	100	258	Md	101	259	No	102	260	Lr	103
Thorium		Protactinium		Uranium		Neptunium		Plutonium		Americium		Curium		Berkelium		Californium		Einsteinium		Fermium		Mendelevium		Nobelium		Lawrencium												

**Grade 10 Chemistry**  
**Spring 2004 Released Items:**  
**Standards and Correct Answers**

Item No.	Page No.	Standard	Correct Answer (MC)*
1	294	6.1	C
2	294	5.2	C
3	295	3.4	C
4	295	2.2	D
5	295	4.2	A
6	296	2.3	A
7	296	8.1	C
8	297	7.2	
9	298	1.1	B
10	298	9.3	C
11	298	4.7	B
12	299	2.10	D
13	300	9.3	C
14	300	6.1	C
15	301	4.1	B
16	301	8.1	B
17	301	5.3	D
18	302	1.4	
19	303	6.2	A
20	303	7.2	C
21	304	5.1	C
22	304	3.2	A

\* 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 website later this year.