

---

## XIX. Chemistry, High School

# High School Chemistry Test

The spring 2017 high school Chemistry test was based on learning standards in the Chemistry content strand of the October 2006 version of the *Massachusetts Science and Technology/Engineering Curriculum Framework*. These learning standards appear on pages 69–73 of the 2006 framework, which is available on the Department website at [www.doe.mass.edu/frameworks/archive.html](http://www.doe.mass.edu/frameworks/archive.html). Massachusetts adopted a new curriculum framework in science and technology/engineering in 2016. A plan for transitioning the MCAS assessments to the new framework is available at [www.doe.mass.edu/mcas/tdd/sci.html?section=resources](http://www.doe.mass.edu/mcas/tdd/sci.html?section=resources).

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

The table at the conclusion of this chapter indicates each item's reporting category and the framework learning standard it assesses. In order to support future test development, items from the spring 2017 Chemistry test are not included in this publication. The omission of these items will have no impact on the reporting of results.

## Test Sessions

The 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 appear on the following pages.

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

During both Chemistry test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English language learner students only. No other reference tools or materials were allowed.

**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	$\text{SO}_4^{2-}$

**Combined Gas Law:**  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

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

**Dilution Formula:**  $M_1 V_1 = M_2 V_2$

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

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

**STP:** 1 atm (101.3 kPa), 273 K (0°C)

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

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

**Avogadro's Number:**  $6.02 \times 10^{23}$  particles/mol

**Nuclear Symbols**

Name	Symbol
Alpha particle	$\alpha$ or ${}^4_2\text{He}$
Beta particle	$\beta$ or ${}^0_{-1}e$
Gamma ray	$\gamma$
Neutron	${}^1_0n$



# Massachusetts Comprehensive Assessment System

## Periodic Table of the Elements

Group (Family)

Period	1A	2A	3A	4A	5A	6A	7A	8A										
1	1 H Hydrogen 1.01	2 He Helium 4.00																
2	1 Li Lithium 6.94	2 Be Beryllium 9.01	3A 5 B Boron 10.81	4A 6 C Carbon 12.01	5A 7 N Nitrogen 14.01	6A 8 O Oxygen 16.00	7A 9 F Fluorine 19.00											
3	1 Na Sodium 22.99	2 Mg Magnesium 24.31	3A 13 Al Aluminum 26.98	4A 14 Si Silicon 28.09	5A 15 P Phosphorus 30.97	6A 16 S Sulfur 32.06	7A 17 Cl Chlorine 35.45											
4	1 K Potassium 39.10	2 Ca Calcium 40.08	3A 13 Al Aluminum 26.98	4A 14 Si Silicon 28.09	5A 15 P Phosphorus 30.97	6A 16 S Sulfur 32.06	7A 17 Cl Chlorine 35.45	8A 18 Ar Argon 39.95										
5	1 Rb Rubidium 85.47	2 Sr Strontium 87.62	3A 13 Al Aluminum 26.98	4A 14 Si Silicon 28.09	5A 15 P Phosphorus 30.97	6A 16 S Sulfur 32.06	7A 17 Cl Chlorine 35.45	8A 18 Ar Argon 39.95										
6	1 Cs Cesium 132.91	2 Ba Barium 137.33	3A 13 Al Aluminum 26.98	4A 14 Si Silicon 28.09	5A 15 P Phosphorus 30.97	6A 16 S Sulfur 32.06	7A 17 Cl Chlorine 35.45	8A 18 Ar Argon 39.95										
7	1 Fr Francium (223)	2 Ra Radium (226)	3A 13 Al Aluminum 26.98	4A 14 Si Silicon 28.09	5A 15 P Phosphorus 30.97	6A 16 S Sulfur 32.06	7A 17 Cl Chlorine 35.45	8A 18 Ar Argon 39.95										
			8B	9	10	11	12											
			1 Sc Scandium 44.96	2 Ti Titanium 47.88	3 V Vanadium 50.94	4 Cr Chromium 52.00	5 Mn Manganese 54.94	6 Fe Iron 55.85	7 Co Cobalt 58.93	8 Ni Nickel 58.69	9 Cu Copper 63.55	10 Zn Zinc 65.39	11 Ga Gallium 69.72	12 Ge Germanium 72.59	13 As Arsenic 74.92	14 Se Selenium 78.96	15 Br Bromine 79.90	16 Kr Krypton 83.80
			1 Y Yttrium 88.91	2 Zr Zirconium 91.22	3 Nb Niobium 92.91	4 Mo Molybdenum 95.94	5 Tc Technetium (98)	6 Ru Ruthenium 101.07	7 Rh Rhodium 102.91	8 Pd Palladium 106.42	9 Ag Silver 107.87	10 Cd Cadmium 112.41	11 In Indium 114.82	12 Sn Tin 118.71	13 Sb Antimony 121.75	14 Te Tellurium 127.60	15 I Iodine 126.91	16 Xe Xenon 131.29
			1 La Lanthanum (138.91)	2 Ce Cerium 140.12	3 Pr Praseodymium 140.91	4 Nd Neodymium 144.24	5 Pm Promethium (145)	6 Sm Samarium 150.36	7 Eu Europium 151.96	8 Gd Gadolinium 157.25	9 Tb Terbium 158.93	10 Dy Dysprosium 162.50	11 Ho Holmium 164.93	12 Er Erbium 167.26	13 Tm Thulium 168.93	14 Yb Ytterbium 173.04	15 Lu Lutetium 174.97	
			1 Ac Actinium (227)	2 Th Thorium 232.04	3 Pa Protactinium 231.04	4 U Uranium 238.03	5 Np Neptunium (237)	6 Pu Plutonium (244)	7 Am Americium (243)	8 Cm Curium (247)	9 Bk Berkelium (247)	10 Cf Californium (251)	11 Es Einsteinium (252)	12 Fm Fermium (257)	13 Md Mendelevium (258)	14 No Nobelium (259)	15 Lr Lawrencium (262)	

Key:

atomic weight
Symbol
atomic number
Name

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

Lanthanide Series

Actinide Series

\*Revised based on IUPAC Commission on Atomic Weights and Isotopic Abundances, "Atomic Weights of the Elements 2007."

**High School Chemistry**  
**Spring 2017 Items:**  
**Reporting Categories and Standards**

<b>Item No.</b>	<b>Reporting Category</b>	<b>2006 Standard</b>
1	<i>Atomic Structure and Periodicity</i>	2.2
2	<i>Properties of Matter and Thermochemistry</i>	1.1
3	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.5
4	<i>Atomic Structure and Periodicity</i>	3.2
5	<i>Properties of Matter and Thermochemistry</i>	6.1
6	<i>Atomic Structure and Periodicity</i>	2.5
7	<i>Properties of Matter and Thermochemistry</i>	6.5
8	<i>Bonding and Reactions</i>	5.6
9	<i>Atomic Structure and Periodicity</i>	3.4
10	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.2
11	<i>Bonding and Reactions</i>	4.1
12	<i>Bonding and Reactions</i>	5.1
13	<i>Bonding and Reactions</i>	8.4
14	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.2
15	<i>Atomic Structure and Periodicity</i>	2.6
16	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.6
17	<i>Bonding and Reactions</i>	5.4
18	<i>Properties of Matter and Thermochemistry</i>	6.3
19	<i>Properties of Matter and Thermochemistry</i>	1.1
20	<i>Bonding and Reactions</i>	4.4
21	<i>Bonding and Reactions</i>	5.2
22	<i>Bonding and Reactions</i>	4.6
23	<i>Properties of Matter and Thermochemistry</i>	6.4
24	<i>Bonding and Reactions</i>	5.3
25	<i>Atomic Structure and Periodicity</i>	3.2
26	<i>Bonding and Reactions</i>	4.5
27	<i>Bonding and Reactions</i>	5.1
28	<i>Properties of Matter and Thermochemistry</i>	6.2
29	<i>Atomic Structure and Periodicity</i>	2.1
30	<i>Bonding and Reactions</i>	4.3
31	<i>Bonding and Reactions</i>	4.2
32	<i>Bonding and Reactions</i>	5.3
33	<i>Properties of Matter and Thermochemistry</i>	1.3
34	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.3
35	<i>Bonding and Reactions</i>	5.5
36	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.4
37	<i>Properties of Matter and Thermochemistry</i>	1.2
38	<i>Atomic Structure and Periodicity</i>	3.1
39	<i>Atomic Structure and Periodicity</i>	3.3
40	<i>Atomic Structure and Periodicity</i>	2.7

<b>Item No.</b>	<b>Reporting Category</b>	<b>2006 Standard</b>
41	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.3
42	<i>Atomic Structure and Periodicity</i>	2.3
43	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.2
44	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.2
45	<i>Atomic Structure and Periodicity</i>	2.4