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

<table>
<thead>
<tr>
<th>Ion</th>
<th>Ionic Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>NH₄⁺</td>
</tr>
<tr>
<td>Carbonate</td>
<td>CO₃²⁻</td>
</tr>
<tr>
<td>Hydroxide</td>
<td>OH⁻</td>
</tr>
<tr>
<td>Nitrate</td>
<td>NO₃⁻</td>
</tr>
<tr>
<td>Phosphate</td>
<td>PO₄³⁻</td>
</tr>
<tr>
<td>Sulfate</td>
<td>SO₄²⁻</td>
</tr>
</tbody>
</table>

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

Ideal Gas Law: \( PV = nRT \)

Dilution Formula: \( M_1V_1 = M_2V_2 \)

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: \( K = °C + 273 \)

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

Avogadro’s Number: \( 6.02 \times 10^{23} \text{ particles/mol} \)

### Nuclear Symbols

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
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</thead>
<tbody>
<tr>
<td>Alpha particle</td>
<td>( \alpha ) or ( _2^4\text{He} )</td>
</tr>
<tr>
<td>Beta particle</td>
<td>( \beta ) or ( _{-1}^0\text{e} )</td>
</tr>
<tr>
<td>Gamma ray</td>
<td>( \gamma )</td>
</tr>
<tr>
<td>Neutron</td>
<td>( _0^1\text{n} )</td>
</tr>
</tbody>
</table>
Massachusetts Comprehensive Assessment System

Periodic Table of the Elements

Key:
- **atomic weight**
- **Symbol**
- **Name**

Group (Family)

1
1.01
H 1
Hydrogen

2
Li 3
Lithium
Be 4
Beryllium

3
Na 11
Sodium
Mg 12
Magnesium

4
K 19
Potassium
Ca 20
Calcium
Sc 21
Scandium
Ti 22
Titanium
V 23
Vanadium
Cr 24
Chromium
Mn 25
Manganese
Fe 26
Iron
Co 27
Cobalt
Ni 28
Nickel
Cu 29
Copper
Zn 30
Zinc
Ga 31
Galium
Ge 32
Germanium
As 33
Arsenic
Se 34
Selenium
Br 35
Bromine
Kr 36
Krypton

5
Rb 37
Rubidium
Sr 38
Strontium
Y 39
Yttrium
Zr 40
Zirconium
Nb 41
Niobium
Mo 42
Molybdenum
Tc 43
Technetium
Ru 44
Ruthenium
Rh 45
Rhodium
Pd 46
 Palladium
Ag 47
Silver
Cd 48
Cadmium
In 49
Indium
Sn 50
Tin
Sb 51
Antimony
Te 52
Tellurium
I 53
Iodine
Xe 54
Xenon

6
Cs 55
Cesium
Ba 56
Barium
La 57
Lanthanum
Ce 58
Cerium
Pr 59
Praseodymium
Nd 60
Neodymium
Pm 61
Promethium
Sm 62
Samarium
Eu 63
Europium
Gd 64
Gadolinium
Tb 65
Terbium
Dy 66
Dysprosium
Ho 67
Holmium
Er 68
Erbium
Tm 69
Thulium
Yb 70
Ytterbium
Lu 71
Lutetium

7
Fr 87
Francium
Ra 88
Radium

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

*Revised based on IUPAC Commission on Atomic Weights and Isotopic Abundances, “Atomic Weights of the Elements 2007.”*
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<thead>
<tr>
<th>Item No.</th>
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<td>Properties of Matter and Thermochemistry</td>
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