



MASSACHUSETTS

Department of Elementary
and Secondary Education

*Release of Spring 2023
MCAS Test Information
from the
High School Chemistry
Paper-Based Test*

**July 2023
Massachusetts Department of
Elementary and Secondary Education**



MASSACHUSETTS

Department of Elementary
and Secondary Education

This document was prepared by the
Massachusetts Department of Elementary and Secondary Education
Jeffrey C. Riley
Commissioner

The Massachusetts Department of Elementary and Secondary Education, an affirmative action employer, is committed to ensuring that all of its programs and facilities are accessible to all members of the public. We do not discriminate on the basis of age, color, disability, gender identity, national origin, race, religion, sex or sexual orientation. Inquiries regarding the Department's compliance with Title IX and other civil rights laws may be directed to the Human Resources Director, 75 Pleasant St., Malden, MA 02148 781-338-6105.

© 2023 Massachusetts Department of Elementary and Secondary Education

Permission is hereby granted to copy for non-commercial educational purposes any or all parts of this document with the exception of English Language Arts passages that are not designated as in the public domain. Permission to copy all other passages must be obtained from the copyright holder. Please credit the "Massachusetts Department of Elementary and Secondary Education."

Massachusetts Department of Elementary and Secondary Education
75 Pleasant Street, Malden, MA 02148-4906
Phone 781-338-3000 TTY: N.E.T. Relay 800-439-2370
www.doe.mass.edu



High School Chemistry Test

The spring 2023 high school Chemistry test was a legacy assessment that was based on learning standards in the Chemistry content strand of the October 2006 version of the *Massachusetts Science and Technology/Engineering Curriculum Framework*. The 2006 framework is available on the Department website at 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=transition.

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 document indicates each item's reporting category and the framework learning standard each item assesses. In order to support future test development, items from the spring 2023 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. 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 learner students only. No other reference tools or materials were allowed.

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: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

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: 6.02×10^{23} particles/mol

Nuclear Symbols

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

Massachusetts Comprehensive Assessment System

Periodic Table of the Elements

Group (Family)

Period	1A	2A	3A	4A	5A	6A	7A	8A
1	1.01 H 1 Hydrogen							4.00 He 2 Helium
2	6.94 Li 3 Lithium	9.01 Be 4 Beryllium						
3	22.99 Na 11 Sodium	24.31 Mg 12 Magnesium						
4	39.10 K 19 Potassium	40.08 Ca 20 Calcium	44.96 Sc 21 Scandium	47.88 Ti 22 Titanium	50.94 V 23 Vanadium	52.00 Cr 24 Chromium	54.94 Mn 25 Manganese	58.93 Fe 26 Iron
5	85.47 Rb 37 Rubidium	87.62 Sr 38 Strontium	88.91 Y 39 Yttrium	91.22 Zr 40 Zirconium	92.91 Nb 41 Niobium	95.94 Mo 42 Molybdenum	98.91 Tc 43 Technetium	101.07 Ru 44 Ruthenium
6	132.91 Cs 55 Cesium	137.33 Ba 56 Barium		178.49 Hf 72 Hafnium	180.95 Ta 73 Tantalum	183.85 W 74 Tungsten	186.21 Re 75 Rhenium	192.22 Os 76 Osmium
7	(223) Fr 87 Francium	(226) Ra 88 Radium		(267) Rf 104 Rutherfordium	(268) Db 105 Dubnium	(271) Sg 106 Seaborgium	(272) Bh 107 Bohrium	(277) Hs 108 Hassium
8								
9								
10								
11								
12								
13	10.81 B 5 Boron	12.01 C 6 Carbon	14.01 N 7 Nitrogen	16.00 O 8 Oxygen	19.00 F 9 Fluorine	20.18 Ne 10 Neon		
14	26.98 Al 13 Aluminum	28.09 Si 14 Silicon	30.97 P 15 Phosphorus	32.06 S 16 Sulfur	35.45 Cl 17 Chlorine	39.95 Ar 18 Argon		
15	69.72 Ga 31 Gallium	72.59 Ge 32 Germanium	74.92 As 33 Arsenic	78.96 Se 34 Selenium	79.90 Br 35 Bromine	83.80 Kr 36 Krypton		
16	114.82 In 49 Indium	118.71 Sn 50 Tin	121.75 Sb 51 Antimony	127.60 Te 52 Tellurium	126.91 I 53 Iodine	131.29 Xe 54 Xenon		
17	204.38 Tl 81 Thallium	207.2 Pb 82 Lead	208.98 Bi 83 Bismuth	(209) Po 84 Polonium	(210) At 85 Astatine	(222) Rn 86 Radon		
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								
61								
62								
63								
64								
65								
66								
67								
68								
69								
70								
71								
72								
73								
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								
88								
89								
90								
91								
92								
93								
94								
95								
96								
97								
98								
99								
100								
101								
102								
103								
104								
105								
106								
107								
108								
109								
110								
111								
112								
113								
114								
115								
116								
117								
118								
119								
120								

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 2023 Unreleased Operational Items:
Reporting Categories and Standards

Item No.	Reporting Category	2006 Standard
1	<i>Properties of Matter and Thermochemistry</i>	1.2
2	<i>Bonding and Reactions</i>	4.1
3	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.3
4	<i>Properties of Matter and Thermochemistry</i>	6.3
5	<i>Atomic Structure and Periodicity</i>	3.4
6	<i>Bonding and Reactions</i>	4.2
7	<i>Bonding and Reactions</i>	4.4
8	<i>Atomic Structure and Periodicity</i>	2.5
9	<i>Properties of Matter and Thermochemistry</i>	6.3
10	<i>Atomic Structure and Periodicity</i>	2.1
11	<i>Bonding and Reactions</i>	5.6
12	<i>Bonding and Reactions</i>	5.1
13	<i>Atomic Structure and Periodicity</i>	2.3
14	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.3
15	<i>Bonding and Reactions</i>	4.3
16	<i>Properties of Matter and Thermochemistry</i>	1.1
17	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.6
18	<i>Atomic Structure and Periodicity</i>	2.7
19	<i>Atomic Structure and Periodicity</i>	3.3
20	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.1
21	<i>Properties of Matter and Thermochemistry</i>	1.1
22	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.4
23	<i>Bonding and Reactions</i>	8.4
24	<i>Bonding and Reactions</i>	5.3
25	<i>Properties of Matter and Thermochemistry</i>	1.3
26	<i>Atomic Structure and Periodicity</i>	3.3
27	<i>Properties of Matter and Thermochemistry</i>	6.2
28	<i>Properties of Matter and Thermochemistry</i>	6.1
29	<i>Bonding and Reactions</i>	5.5
30	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.1
31	<i>Atomic Structure and Periodicity</i>	2.4
32	<i>Bonding and Reactions</i>	5.2
33	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.5

Item No.	Reporting Category	2006 Standard
34	<i>Properties of Matter and Thermochemistry</i>	1.2
35	<i>Bonding and Reactions</i>	5.4
36	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	8.2
37	<i>Properties of Matter and Thermochemistry</i>	6.2
38	<i>Atomic Structure and Periodicity</i>	3.2
39	<i>Bonding and Reactions</i>	4.6
40	<i>Properties of Matter and Thermochemistry</i>	6.4
41	<i>Atomic Structure and Periodicity</i>	2.2
42	<i>Atomic Structure and Periodicity</i>	3.1
43	<i>Solutions, Equilibrium, and Acid-Base Theory</i>	7.2
44	<i>Atomic Structure and Periodicity</i>	2.6
45	<i>Properties of Matter and Thermochemistry</i>	6.5