

VIRGINIA STANDARDS OF LEARNING

TEST ITEM SET

# CHEMISTRY

## 2010 Science Standards of Learning

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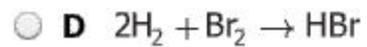
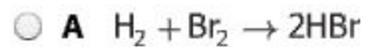
Released Spring 2015

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**SAMPLE A**

**Which of the following is a balanced equation?**



Directions: Click and drag a term into each box. Each term may be used more than once.

### SAMPLE B

A student conducted an investigation to determine the effect of water temperature on the amount of sugar that dissolves in a beaker of water. Identify components for trial 1 of this investigation.

Trial 1

Beaker Number	Amount of Water (mL)	Temperature of Sugar (°C)	Temperature of Water (°C)	Amount of Sugar Dissolved (g)
1	100	20	5	185
2	100	20	10	189
3	100	20	15	194
4	100	20	20	204

Terms

Variable

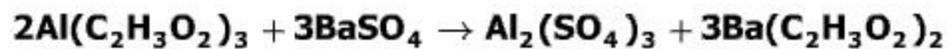
Constant

A student measures the mass of a 1.00 g aluminum rod as 0.99 g. The best estimate of the percent error associated with this measurement is —

- A 0.01%
- B 0.1%
- C 1%
- D 10%

**The most efficient way to determine whether a reaction is an exothermic chemical reaction is to use —**

- A** an oxygen probe
- B** a temperature probe
- C** a pressure probe
- D** a pH probe



Which type of chemical reaction does this equation represent?

- A Synthesis
- B Neutralization
- C Oxidation-reduction
- D Double-replacement

Directions: Type your answer in the box. Use "+" or "-" for the electrical charge.

What is the oxidation number of an oxide ion?

What is the molarity of a solution with 0.2 moles of potassium permanganate ( $\text{KMnO}_4$ ) dissolved in enough water to make a 500.0 mL solution?

- A 0.0004 M
- B 0.1 M
- C 0.4 M
- D 100 M

When 92.0 g of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) are vaporized at its boiling point of  $78.3^\circ\text{C}$ , it requires 78.6 kJ of energy. What is the approximate molar heat of vaporization of ethanol in kJ/mol?

- A 0.854
- B 1.17
- C 39.3
- D 78.3

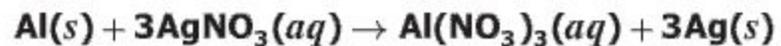
Directions: Type your answer in the box. Your answer must use significant digits.

What is the density of an aqueous solution that has a mass of 10.081 g and 12.5 mL?

g/mL

**Which element has 16 neutrons, 15 protons, and 15 electrons?**

- A** Sulfur (S)
- B** Phosphorus (P)
- C** Gallium (Ga)
- D** Zinc (Zn)



**This equation represents which type of chemical reaction?**

- A** Single-replacement
- B** Double-replacement
- C** Decomposition
- D** Synthesis

**In the formula for barium chloride, ( $\text{BaCl}_2$ ), barium (Ba) is written first because it is —**

- A** a single atom
- B** a larger atom
- C** the positive ion
- D** the negative ion

**Which of these laboratory techniques is best to separate a solid from a liquid to recover the liquid?**

- A** Titration
- B** Chromatography
- C** Filtering
- D** Vaporization

**Which of these is NOT required to ensure that stock solutions are free of contamination?**

- A** Store all solutions in brown bottles
- B** Do not place dropping pipettes in stock solution bottles
- C** Never return excess chemicals to stock bottles
- D** Replace tops on reagent bottles after use

**Which of these values is most responsible for changing the boiling and freezing points of a solvent?**

- A** Molar mass of the solvent
- B** Electronegativity of the solvent
- C** Weight of the solute particles
- D** Number of the solute particles

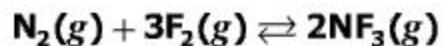
**What is the name of the compound with the formula  $\text{NH}_4\text{NO}_3$  ?**

- A** Ammonium nitrate
- B** Nitrogen nitrate
- C** Nitrogen hydrogen oxide
- D** Ammonium nitrogen trioxide

Directions: Type your answer in the box.

Calculate the number of moles of  $\text{Li}_3\text{PO}_4$  in 2.2 L of a 0.60 M  $\text{Li}_3\text{PO}_4$  solution.

moles



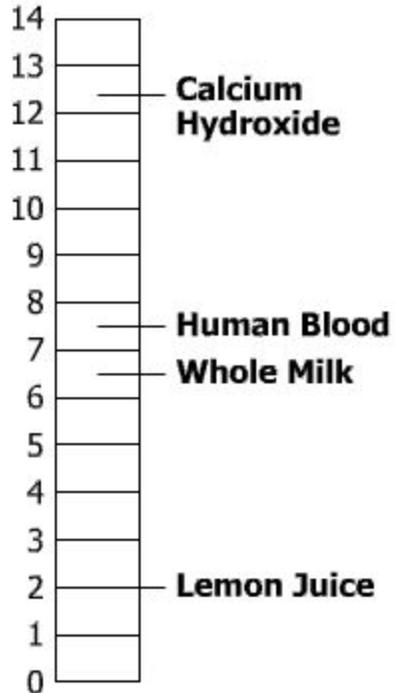
**Equilibrium has been reached for the reaction shown. Which conclusion is correct?**

- A** The  $\text{N}_2$  and  $\text{F}_2$  together will form at a faster rate than the  $\text{NF}_3$ .
- B** The partial pressures of  $\text{N}_2$ ,  $\text{F}_2$ , and  $\text{NF}_3$  will stay constant.
- C** The  $\text{NF}_3$  will form at a faster rate than the  $\text{N}_2$  and  $\text{F}_2$  together.
- D** The partial pressure of  $\text{NF}_3$  will keep changing.

If 89.6 joules of heat are needed to heat 20.0 grams of iron from 30.0°C to 40.0°C, what is the specific heat of the iron in  $\frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}$  ?

- A 0.448
- B 2.23
- C 8.96
- D 896

**pH Scale of  
Various Substances**



**Which of the four substances on this pH scale is slightly basic?**

- A** Calcium hydroxide
- B** Human blood
- C** Whole milk
- D** Lemon juice

**Which element will most likely form covalent bonds with fluorine?**

- A** Carbon
- B** Potassium
- C** Neon
- D** Tin

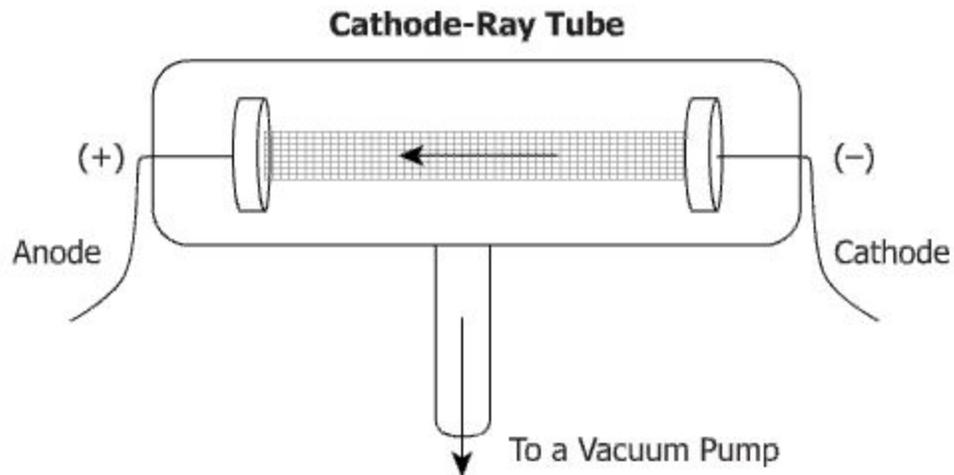
**The physical process of evaporation involves —**

- A** ion formation
- B** electron sharing
- C** transferring valence electrons
- D** overcoming intermolecular forces



How many moles of  $\text{O}_2$  are in the chemical equation when balanced using the lowest whole numbers?

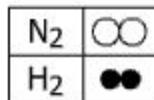
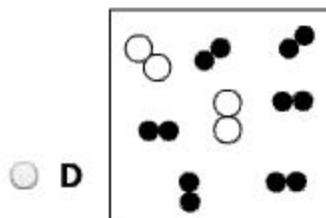
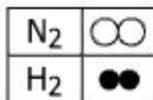
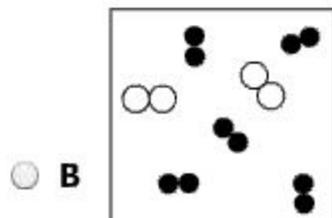
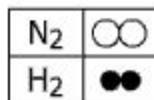
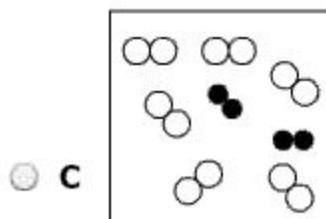
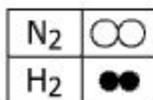
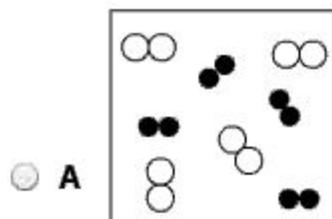
- A 5
- B 4
- C 3
- D 2



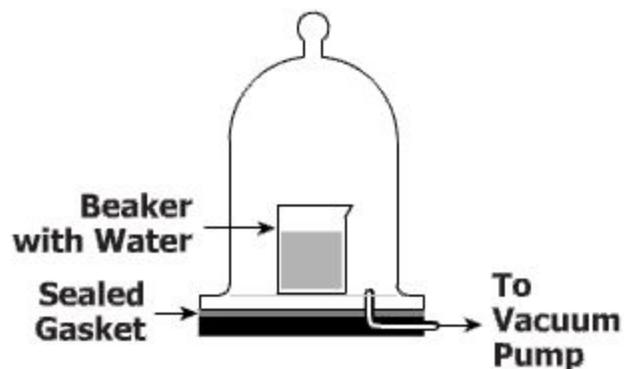
**While English physicist J. J. Thomson was carrying out experiments on cathode rays, he was able to determine that the rays consisted of particles he called "corpuscles." These particles were later named —**

- A** protons
- B** electrons
- C** gamma rays
- D** neutrons

In the Haber process, nitrogen ( $N_2$ ) and hydrogen ( $H_2$ ) are directly combined to form ammonia ( $NH_3$ ). Which illustration contains the stoichiometric quantities of the reactants for this reaction?



### Thick-Walled Vacuum Jar



**A beaker of water is placed in a large sealed jar that is attached to a vacuum pump. As air is pumped out of the jar, the water begins to boil because —**

- A** the temperature of the water decreases as the surrounding pressure decreases
- B** the lower pressure inside the jar causes the water to contract
- C** the air pressure in the jar has been lowered until it is equal to the vapor pressure of the water
- D** the pressure on the water is insufficient to hold the hydrogen and oxygen atoms together, resulting in a decomposition reaction

**Directions: Click on the correct answers.**

**According to the periodic table of the elements, which elements belong to the same period?**

Aluminum

Germanium

Antimony

Arsenic

Gallium

How many moles are in  $2.04 \times 10^{24}$  molecules of  $\text{H}_2\text{O}$ ?

- A 0.295 mol
- B 3.39 mol
- C  $1.13 \times 10^{24}$  mol
- D  $1.44 \times 10^{48}$  mol

**What is the name for  $\text{FeCl}_3$  using the IUPAC nomenclature rules?**

- A** Iron chloride
- B** Iron(II) chloride
- C** Iron trichloride
- D** Iron(III) chloride

Directions: Type your answer in the box.

An expandable container of oxygen gas has a volume of 125 mL at a temperature of 25.0°C. What volume will the gas occupy at 55.0°C ?

mL

**Which of these correctly describes how organic catalysts operate in biological reactions?**

- A** They are used up in the reactions.
- B** They lower the overall energy of the reactions.
- C** They lower the activation energy of the reactions.
- D** They keep the temperature of the reactions constant.

What volume will 35.9 g of hydrogen gas ( $H_2$ ) occupy at STP?

- A 399 L
- B 798 L
- C 804 L
- D 1,620 L



When this equation is balanced, the coefficient in front of  $\text{H}_3\text{PO}_4$  is —

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

**Increasing the volume of a sealed container will cause the gas particles within the container to —**

- A** form a liquid
- B** collide more frequently
- C** increase in molecular attraction
- D** exhibit lower pressure

**Melting Point Results (°C)**

<b>Trial</b>	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 4</b>
1	113	114	116	110
2	111	115	113	111
3	110	111	114	111
4	110	110	113	110

**Each of four groups of students determined and recorded the melting point of a solid compound. If the actual melting point is 113°C, which group had the best precision?**

- A** Group 1
- B** Group 2
- C** Group 3
- D** Group 4

**Consider any set of three adjacent elements in the same period on the periodic table. For which characteristic is the average for the three elements always equal to the value of the middle element?**

- A** Atomic number
- B** Atomic mass
- C** Number of neutrons
- D** Number of isotopes

A substance has a molecular formula of  $C_8H_{10}N_4O_2$ . The empirical formula is —

- A  $C_2H_6N_2O$
- B  $C_4H_5N_2O$
- C  $C_9H_7N_3O$
- D CHNO

Directions: Click and drag the correct answers to the boxes.

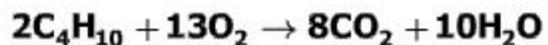
Create the formula for diboron trioxide using the symbols provided.

Symbols

B	b
O	o
1	2
3	4

**What is the name for the compound  $\text{AlI}_3$  ?**

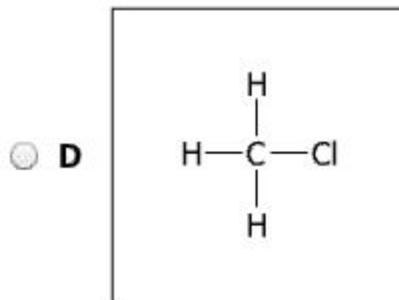
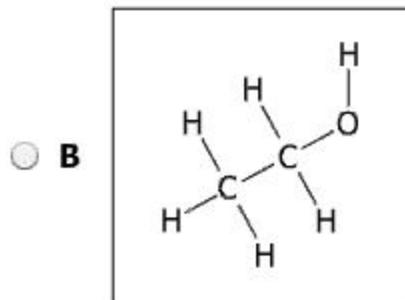
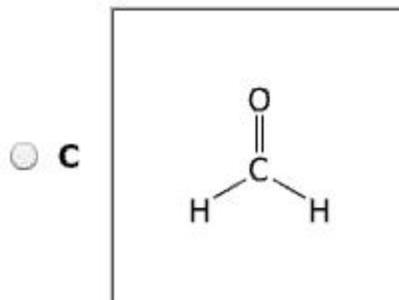
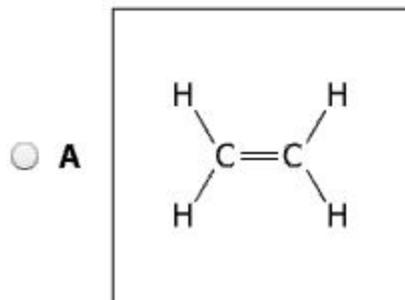
- A** Aluminum(I) iodide
- B** Aluminum triiodide
- C** Aluminum(III) iodide
- D** Aluminum iodide



How many moles of carbon dioxide ( $\text{CO}_2$ ) are produced when reacting 6.00 moles of butane ( $\text{C}_4\text{H}_{10}$ ) in excess oxygen ( $\text{O}_2$ )?

- A 1.50 mol
- B 24.0 mol
- C 66.0 mol
- D 1,060 mol

Which structure represents a nonpolar molecule?



**Using only one trial to collect data in an experiment —**

- A** makes it easier to determine a valid conclusion
- B** reduces the percent error in the results
- C** causes the conclusion to be less reliable
- D** requires data with more significant figures

**A common product of acid-base neutralization reactions is —**

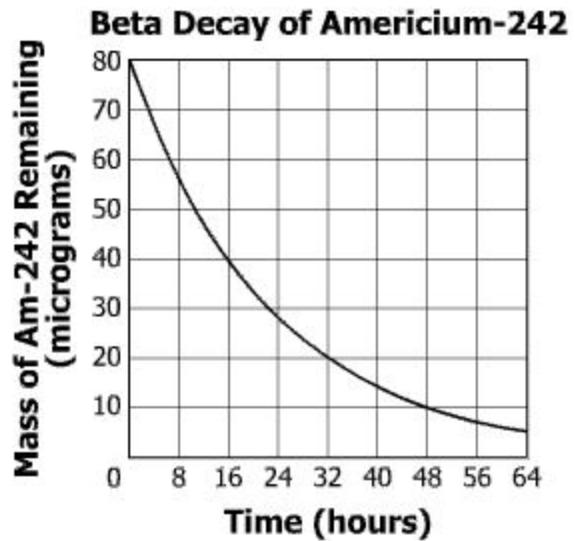
- A** hydrogen
- B** water
- C** carbon dioxide
- D** oxygen

**Data Table**

<b>Solution</b>	<b>Brightness of Light Bulb</b>	<b>pH</b>
NaHCO <sub>3</sub>	Bright	8.4
HClO	Dim	3.7
NaNO <sub>3</sub>	Bright	7.0
CH <sub>3</sub> NH <sub>2</sub>	Dim	8.0

**Based on the information provided, which solution is a base and a weak electrolyte?**

- A** NaHCO<sub>3</sub>
- B** HClO
- C** NaNO<sub>3</sub>
- D** CH<sub>3</sub>NH<sub>2</sub>



**What is the half-life of Americium-242?**

- A** 11 hours
- B** 16 hours
- C** 32 hours
- D** 64 hours



Two electrons are shared equally in bromine ( $\text{Br}_2$ ). What type of bond is represented between the bromine atoms in this Lewis structure?

- A Nonpolar covalent bond
- B Polar covalent bond
- C Metallic bond
- D Ionic bond

**A student is studying the effects of several solutions on the prevention of the browning of apples. The student used solutions having different pH values and immersed three apple slices in equal volumes of each of the solutions. Which of these is the independent variable in this investigation?**

- A** pH of solution
- B** Shade of brown
- C** Number of apple slices
- D** Volume of solutions

An experiment produced 0.10 g CO<sub>2</sub> with a volume of 0.056 L at STP. If the accepted density of CO<sub>2</sub> at STP is 1.96 g/L, what is the approximate percent error?

- A 110%
- B 92%
- C 71%
- D 8.2%

**Chemistry**  
**Released Test Item Set Spring 2015**  
**Answer Key**

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
1	MC	C	001	Scientific Investigation
2	MC	B	001	Scientific Investigation
3	MC	D	003	Chemical Formulas and Reactions
4	TEI	<p>Typed Response: -2 OR 2-</p> <div style="border: 1px solid black; padding: 10px;"> <p style="text-align: center; margin: 0;"><b>Directions: Type your answer in the box. Use "+" or "-" for the electrical charge.</b></p> <p style="text-align: center; margin: 10px 0 0 0;">What is the oxidation number of an oxide ion?</p> <div style="text-align: center; margin: 10px 0 0 100px;"> <input style="border: 1px solid gray; padding: 2px 10px;" type="text" value="-2"/> </div> </div>	002	Atomic Structure and Periodic Relationships
5	MC	C	004	Molar Relationships
6	MC	C	005	Phases of Matter and Kinetic Molecular Theory

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
7	TEI	Typed response: .806 OR 0.806 <div style="border: 1px solid black; padding: 10px; margin-top: 5px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">Directions: Type your answer in the box. Your answer must use significant digits.</p> <p style="text-align: center; margin: 10px 0;">What is the density of an aqueous solution that has a mass of 10.081 g and 12.5 mL?</p> <p style="text-align: center; margin: 0;"> <input style="width: 50px; text-align: center;" type="text" value=".806"/> g/mL         </p> </div>	001	Scientific Investigation
8	MC	B	002	Atomic Structure and Periodic Relationships
9	MC	A	003	Chemical Formulas and Reactions
10	MC	C	003	Chemical Formulas and Reactions
11	MC	C	001	Scientific Investigation
12	MC	A	001	Scientific Investigation
13	MC	D	005	Phases of Matter and Kinetic Molecular Theory
14	MC	A	003	Chemical Formulas and Reactions

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
15	TEI	<p>Typed Response: 1, 1., 1.3, 1.32, 1.33, 1.4, 2, OR 2. One of the answers is shown below.</p> <div style="border: 1px solid black; padding: 10px;"> <p>Directions: Type your answer in the box.</p> <p>Calculate the number of moles of <math>\text{Li}_3\text{PO}_4</math> in 2.2 L of a 0.60 M <math>\text{Li}_3\text{PO}_4</math> solution.</p> <p style="text-align: center;"><input style="width: 50px;" type="text" value="1.3"/> moles</p> </div>	004	Molar Relationships
16	MC	B	003	Chemical Formulas and Reactions
17	MC	A	005	Phases of Matter and Kinetic Molecular Theory
18	MC	B	004	Molar Relationships
19	MC	A	003	Chemical Formulas and Reactions
20	MC	D	005	Phases of Matter and Kinetic Molecular Theory
21	MC	C	003	Chemical Formulas and Reactions
22	MC	B	002	Atomic Structure and Periodic Relationships
23	MC	D	004	Molar Relationships
24	MC	C	005	Phases of Matter and Kinetic Molecular Theory

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
25	TEI	<p>These answers, and only these answers, must be selected:            Germanium (second box from left); Arsenic (fourth box from left); Gallium (fifth box from left)</p> <div style="border: 1px solid gray; padding: 5px;"> <p>Directions: Click on the correct answers.</p> <p>According to the periodic table of the elements, which elements belong to the same period?</p> <div style="border: 1px solid gray; padding: 5px; display: flex; justify-content: space-around; width: fit-content; margin: 0 auto;"> <span>Aluminum</span> <span style="border: 2px solid orange; padding: 2px;">Germanium</span> <span>Antimony</span> <span style="border: 2px solid orange; padding: 2px;">Arsenic</span> <span style="border: 2px solid orange; padding: 2px;">Gallium</span> </div> </div>	002	Atomic Structure and Periodic Relationships
26	MC	B	004	Molar Relationships
27	MC	D	003	Chemical Formulas and Reactions

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
28	TEI	<p>Typed Response: 130, 130., 137, 137., 137.5, 137.6, 138, 138., 140, OR 140. One of the answers is shown below.</p> <div style="border: 1px solid black; padding: 10px;"> <p>Directions: Type your answer in the box.</p> <p>An expandable container of oxygen gas has a volume of 125 mL at a temperature of 25.0°C. What volume will the gas occupy at 55.0°C ?</p> <p style="text-align: center;"><input style="width: 50px;" type="text" value="138"/> mL</p> </div>	005	Phases of Matter and Kinetic Molecular Theory
29	MC	C	003	Chemical Formulas and Reactions
30	MC	A	004	Molar Relationships
31	MC	B	003	Chemical Formulas and Reactions
32	MC	D	005	Phases of Matter and Kinetic Molecular Theory
33	MC	D	001	Scientific Investigation
34	MC	A	002	Atomic Structure and Periodic Relationships
35	MC	B	003	Chemical Formulas and Reactions

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
36	TEI	<p>The symbols must be placed in the correct order from left to right: B; 2; O; 3</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p><b>Directions: Click and drag the correct answers to the boxes.</b></p> <p>Create the formula for diboron trioxide using the symbols provided.</p> <div style="text-align: center;"> <p><b>Symbols</b></p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="display: flex; gap: 20px;"> <div style="border: 1px solid black; padding: 2px 5px;">B</div> <div style="border: 1px solid black; padding: 2px 5px;">2</div> <div style="border: 1px solid black; padding: 2px 5px;">O</div> <div style="border: 1px solid black; padding: 2px 5px;">3</div> </div> <div style="border: 1px solid black; padding: 5px;"> <div style="border: 1px solid black; padding: 2px 5px; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">b</div> <div style="border: 1px solid black; padding: 2px 5px; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">o</div> <div style="border: 1px solid black; padding: 2px 5px; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">1</div> <div style="border: 1px solid black; padding: 2px 5px; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">4</div> </div> </div> </div> </div>	003	Chemical Formulas and Reactions
37	MC	D	003	Chemical Formulas and Reactions
38	MC	B	004	Molar Relationships
39	MC	A	002	Atomic Structure and Periodic Relationships
40	MC	C	001	Scientific Investigation
41	MC	B	003	Chemical Formulas and Reactions

Sequence Number	Item Type: Multiple Choice (MC) or Technology-Enhanced Item (TEI)	Correct Answer	Reporting Category	Reporting Category Description
42	MC	D	004	Molar Relationships
43	MC	B	002	Atomic Structure and Periodic Relationships
44	MC	A	003	Chemical Formulas and Reactions
45	MC	A	001	Scientific Investigation
46	MC	D	001	Scientific Investigation

