

**VIRGINIA
STANDARDS OF LEARNING ASSESSMENTS**

Spring 2001 Released Test

**END OF COURSE
CHEMISTRY**

Property of the Virginia Department of Education

© 2001 by the Commonwealth of Virginia Department of Education, James Monroe Building, 101 N. 14th Street, Richmond, Virginia, 23219. All rights reserved. Except as permitted by law, this material may not be reproduced or used in any form or by any means, electronic or mechanical, including photocopying or recording, or by any information storage or retrieval system, without written permission from the copyright owner. Commonwealth of Virginia public school educators may photocopy or print any portion of these Released Tests for educational purposes without requesting permission. All others should direct their requests to the Commonwealth of Virginia Department of Education at (804) 225-2102, Division of Assessment and Reporting.

Chemistry

DIRECTIONS

Read each question carefully and choose the best answer. Then mark the space on the answer sheet for the answer you have chosen.

SAMPLE

Which of the following is a balanced equation?

- A $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$
- B $\text{H}_2 + \text{Br}_2 \rightarrow \text{HBr}$
- C $\text{H}_2 + 2\text{Br}_2 \rightarrow 2\text{HBr}$
- D $2\text{H}_2 + \text{Br}_2 \rightarrow \text{HBr}$

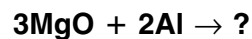
1 To remove the sand first and then the salt from a mixture of sand and salt water, one combination of techniques you could use would be to *first* —

- A evaporate and then distill
- B evaporate and then condense
- C filter and then evaporate
- D filter and then condense

2 Which is an example of a synthesis reaction?

- F $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}$
- G $\text{Pb}(\text{NO}_3)_2 + 2\text{HBr} \rightarrow \text{PbBr}_2 + 2\text{HNO}_3$
- H $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$
- J $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$

3



What would be the product(s) of this reaction?

- A $2\text{Mg}_3\text{Al}_2\text{O}_3$
- B $\text{Mg}_3\text{Al}_2 + 3\text{O}_2$
- C $6\text{Mg} + \text{Al}_3\text{O}_2$
- D $3\text{Mg} + \text{Al}_2\text{O}_3$

4 One of the main assumptions of the kinetic molecular theory of gases is that the particles of an ideal gas —

- F** must be single atoms instead of molecules
- G** are in constant motion
- H** must be maintained at very high pressures
- J** must be highly chemically reactive

5 Which is the correct formula for iron (III) sulfate?

- A** $\text{Fe}_3(\text{SO}_4)_2$
- B** FeSO_4
- C** $\text{Fe}_2(\text{SO}_4)_3$
- D** $\text{Fe}_2(\text{SO}_3)_3$

6 Which of these represents the empirical formula and the molecular formula, respectively, for a given organic compound?

- F** CH and C_2H_2
- G** CH and CH_4
- H** CH_2 and C_2H_2
- J** CH_3 and C_3H_{12}

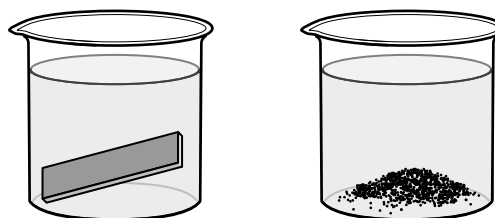
7 **Specific Heat Capacities of Some Common Substances**

Substance	Specific Heat Capacity (cal/g • °C)
Aluminum	0.21
Alcohol	0.58
Water	1.00
Wood	0.42

What probably causes water to have the highest specific heat of the substances listed above?

- A Molecule size
- B Molecular mass
- C Strong hydrogen bonds
- D High density of ice

8



Beaker A

Beaker B

Each beaker shown above contains 2.2 grams of iron and 1 liter of 3M H₂SO₄ at STP. Which reaction will go to completion first and why?

- F Beaker A because of increased surface area
- G Beaker B because of increased surface area
- H Beaker A because of a higher concentration level
- J Beaker B because of a higher concentration level

9 **The element chlorine exists as two naturally occurring isotopes. Cl-35 occurs 75% of the time and Cl-37 occurs 25% of the time. Which of the following calculations should be used to calculate the correct average atomic mass of chlorine?**

- A $(35 \text{ amu} \times .75) + (37 \text{ amu} \times .25)$
- B $\frac{(35 \text{ amu} \times 3) + 37 \text{ amu}}{2}$
- C $\frac{(35 \text{ amu} \times 3) + 37 \text{ amu}}{3}$
- D $\frac{35 \text{ amu} + 37 \text{ amu}}{2}$

10 The average kinetic energy of a sample of water molecules is —

- F increased as the temperature is decreased
- G increased as the temperature is increased
- H unaffected by temperature changes
- J always equal to zero

11

Electronegativity Values of Some Atoms

2.1						
H						
1.0	1.5	2.0	2.5	3.0	3.5	4.0
Li	Be	B	C	N	O	F
0.9	1.2	1.5	1.8	2.1	2.5	3.0
Na	Mg	Al	Si	P	S	Cl
0.8	1.0				2.4	2.8
K	Ca				Se	Br

Electronegativity differences are often helpful in determining the bond character between two atoms. A general rule states that if the electronegativity difference between two atoms is greater than 1.67, an ionic bond would most likely be formed. Using the chart above, which pair of atoms would probably form the strongest ionic bond?

- A Al-P
- B Na-Cl
- C K-F
- D Ca-O

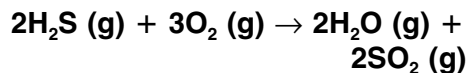
12 The mass of an object was recorded as 9.93 g, 9.90 g, and 10.02 g, using an electronic analytical balance. What is the average of these three masses expressed to the correct number of significant figures?

- F 9.9 g
- G 9.95 g
- H 10.0 g
- J 10.00 g

13 Radioactive iodine-131 has a half-life of eight days. The amount of a 200.0 gram sample left after 32 days would be —

- A 6.25 g
- B 12.5 g
- C 25.0 g
- D 50.0 g

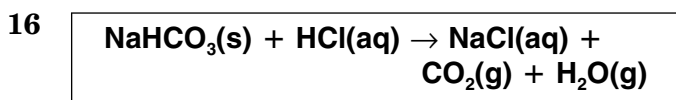
14



If 3.50 g of H_2S are used in the above reaction, what will be the theoretical yield of water in grams?

- F 0.102 g
- G 0.185 g
- H 1.85 g
- J 185 g

- 15 Which of these describes a tendency for atomic radii as displayed on the periodic chart?
- A Atomic radii decrease left to right across a period.
- B Atomic radii increase left to right across a period.
- C Atomic radii decrease top to bottom down a group.
- D Atomic radii increase, then decrease from top to bottom down a group.



Data Table

evaporating dish + watch glass	42.70 g
evaporating dish + watch glass + NaHCO ₃	45.20 g
evaporating dish + watch glass + NaCl	44.45 g

A student conducted an experiment and was interested in the mass of the product of the chemical reaction. Some results of the experiment are shown above. What is the mass of the NaCl?

- F 0.75 g
- G 1.75 g
- H 2.25 g
- J 2.50 g

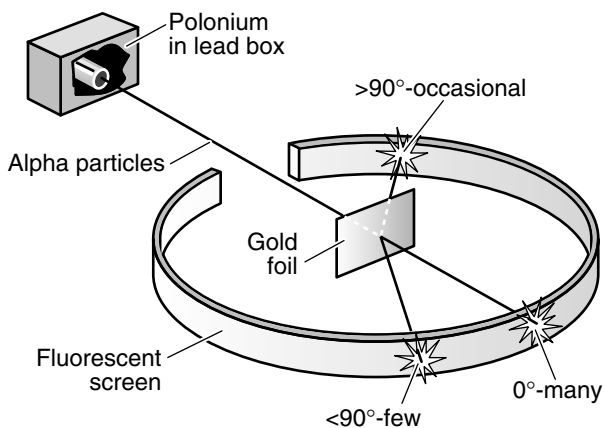
- 17 A solution contains 225 g of glucose, C₆H₁₂O₆, dissolved in enough water to make 0.825 L of solution. What is the molarity of the solution?
- A 0.66 M
- B 0.97 M
- C 1.03 M
- D 1.52 M

- 18 A student wanted to calculate the formula for hydrated copper sulfate. After careful massing, she heated the compound to remove the water. She calculated the formula to be CuSO₄ · 4H₂O. The actual formula was CuSO₄ · 5H₂O. What is the most likely source of analytical error in the student's experiment?

- F The water was not completely evaporated from the compound.
- G The actual mass of the anhydrous CuSO₄ was less than the measurement.
- H The CuSO₄ reacted with elemental copper.
- J The atmospheric pressure prevented complete reaction.

- 19 What is the percentage of aluminum in aluminum oxide (Al₂O₃)?
- A 47%
- B 48%
- C 53%
- D 54%

20



Which of these conclusions can be drawn from Rutherford's experiment?

- F Each atom contains electrons.
- G The nucleus of an atom can be split.
- H Each atom contains protons.
- J Atoms are mostly empty space.

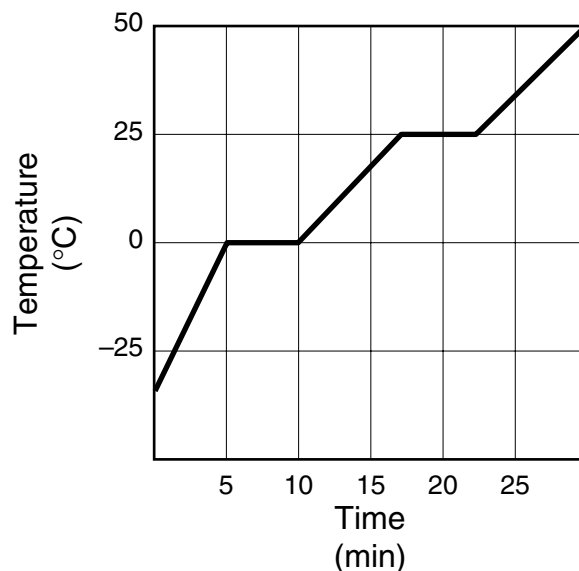
21 How does the radioactive isotope C-14 differ from its stable counterpart C-12?

- A It has a different number of protons and two less neutrons than C-12.
- B It has the same number of protons and two more electrons than C-12.
- C It has the same number of protons but two more neutrons than C-12.
- D It has a different number of protons and two more neutrons than C-12.

22 A compound has 50% sulfur and 50% oxygen. What is its empirical formula?

- F SO_4
- G S_2O_4
- H SO_3
- J SO_2

23



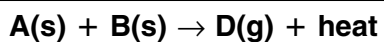
An experiment yielded the above temperature and time information. What is the freezing point of the material in this experiment if the material is a solid at time zero?

- A -25°C
- B 0°C
- C 25°C
- D 50°C

24 How many milliliters of 2.00 M H_2SO_4 are needed to provide 0.250 mole of H_2SO_4 ?

- F 125 mL
- G 1.25×10^1 mL
- H 8.00×10^3 mL
- J 8.00 mL

25



The reaction shown above is —

- A an endothermic reaction
- B an exothermic reaction
- C a decomposition reaction
- D a double-replacement reaction

26 Chlorine forms a 1- ion. How many electrons does a chloride ion have?

- F 1
- G 16
- H 17
- J 18

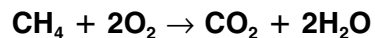
27

Group	Mass Data for Sample X (g)	Displacement Data for Sample X (mL)
1	2.7	3.4
2	1.20	1.5
3	6.2	7.40

According to the above data, which of the following represents the average density for sample X using the correct number of significant figures?

- A 1 g/mL
- B 0.8 g/mL
- C 0.81 g/mL
- D 0.821 g/mL

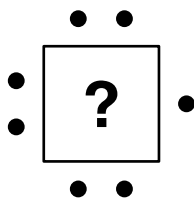
28



The number of grams of oxygen required for the complete combustion of 4.00 grams of methane (CH_4) is —

- F 4.00 g
- G 8.00 g
- H 16.0 g
- J 32.0 g

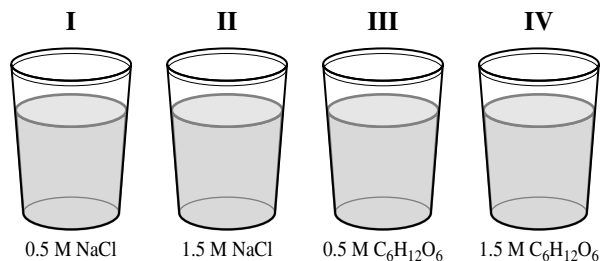
29



Which of the groups below has the electron dot structure shown above?

- A Noble gases
 B Halogens
 C Alkali metals
 D Transition elements
- 30 A student must make a 3 M acid solution using a 5 M acid solution. Which of these is the safest way to make the solution?
- F Slowly pour the 5 M acid into water
 G Slowly add water to the 5 M acid solution
 H Mix half the acid with water, then add the remaining water
 J Mix half the water with the acid, then add the remaining acid

31



Four aqueous solutions and their concentrations are shown in the above illustration. Which of the solutions is most likely to be the strongest conductor of electricity?

- A I
 B II
 C III
 D IV
- 32 Water can be made to boil *above* its normal boiling point of 100°C by —
- F decreasing the air pressure
 G increasing the air pressure
 H increasing the heat being applied
 J decreasing the volume of the container
- 33 What is the first step that should be taken when a caustic chemical gets into a person's eye?
- A Identify the chemical
 B Call for an ambulance
 C Flush the affected area with water
 D Apply a neutralizing agent

34 **Melting and Boiling Points of Some Bond Types**

Substance	Type of Bond	Boiling Point	Melting Point	Phase at 24°C
Helium	atom (monatomic)	-269°C	-272°C	gas
Hydrogen	molecule (nonpolar covalent)	-253°C	-259°C	gas
Iron	atom (metallic crystal)	3000°C	1535°C	solid
Sodium chloride	ionic crystal	1413°C	800°C	solid
Water	molecule (polar covalent)	100°C	0°C	liquid

According to the table, which of these probably has the strongest bonds?

- F Hydrogen gas
- G Iron crystals
- H Sodium chloride
- J Water

35 In the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$, which change would cause the greatest increase in the concentration of SO_3 ?

- A Decrease the concentration of SO_2
- B Decrease the concentration of O_2
- C Increase the concentration of SO_2
- D Increase the concentration of O_2

36 A catalyst accelerates a chemical reaction because the —

- F catalyst decreases the number of collisions in a reaction
- G activation energy of the reaction is lowered in the presence of a catalyst
- H catalyst decreases the concentration of the reactants
- J temperature of the reaction increases due to the catalyst

37 A compound is composed of 58.8% C, 9.8% H, and 31.4% O, and the molar mass is 102 g/mol. What is the molecular formula for this compound?

- A $\text{C}_2\text{H}_{10}\text{O}_3$
- B $\text{C}_5\text{H}_5\text{O}_3$
- C $\text{C}_5\text{H}_{10}\text{O}_2$
- D CH_3O_3

38 Which of these shows a volume of 1.25 liters expressed in milliliters?

- F 125 mL
- G 12.5×10^1 mL
- H 1.25×10^2 mL
- J 1.25×10^3 mL

39 An element has an electron configuration of $1s^2 2s^2 2p^6 3s^2$. Which of these will be in the same group as this element?

- A $1s^2 2s^2 2p^6$
- B $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
- C $1s^2 2s^2 2p^6 3s^1$
- D $1s^2 2s^2 2p^6 3s^2 3p^6$

40

Very Active Metal + Water → Metal Hydroxide + ?
--

Which of these completes this reaction?

- F Oxygen
- G Hydrogen
- H Metal oxide
- J Air

41 Which of these elements is the most chemically active?

- A F
- B Cl
- C Br
- D I

42 If the heat of fusion of water is 3.4×10^2 J/g, the amount of heat energy required to change 15.0 grams of ice at 0°C to 15.0 grams of water at 0°C is —

- F 3.4×10^2 J
- G 2.4×10^3 J
- H 5.1×10^3 J
- J 1.0×10^4 J

43 If the pressure exerted on a confined gas is doubled, then the volume of the gas —

- A increases four times
- B decreases by one-fourth
- C is doubled
- D is halved

44 If the temperature of a reaction is increased, the reaction proceeds at a much quicker rate because the —

- F activation energy increases
- G energy of the products increases
- H frequency of collisions between reactants increases
- J energy of the activated complex increases

45 The formula H_2SO_4 is representative of which of the following?

- A A catalyst
- B A base
- C An acid
- D An organic compound

46 Which compound contains both ionic and covalent bonds?

- F NH_4Cl
- G MgBr_2
- H CH_4
- J NH_3

47 Which volume will be occupied by a gas containing 6.02×10^{23} atoms at STP?

- A 1.0 L
- B 11.2 L
- C 22.4 L
- D 44.8 L

49 A sample of oxygen gas is collected over water at 22°C and 98.67 kPa pressure. If the partial pressure of the water is 2.67 kPa, the partial pressure of the oxygen is —

- A 93.33 kPa
- B 96.00 kPa
- C 98.66 kPa
- D 101.33 kPa

48 **Some Solubilities in Water**

Key
 i = nearly insoluble
 ss = slightly soluble
 s = soluble
 n = not isolated

	acetate	bromide	carbonate	chloride	chromate	hydroxide
Aluminum	ss	s	n	s	n	i
Ammonium	s	s	s	s	s	s
Barium	s	s	i	s	i	s
Calcium	s	s	i	s	s	ss
Copper (II)	s	s	i	s	i	i
Iron (II)	s	s	i	s	n	i

Using the chart above, which of these combinations will probably form a precipitate?

- F Ammonium chloride
- G Barium bromide
- H Calcium chromate
- J Copper (II) carbonate

50 The hydrogen ion concentration is 1×10^{-7} . What is the pH of this solution?

- F 1
- G 7
- H 10
- J 14



Answer Key

Test Sequence	Correct Answer	Reporting Category	Reporting Category Description
1	C	001	Scientific Investigation
2	H	003	Nomenclature, Chemical Formulas, and Reactions
3	D	003	Nomenclature, Chemical Formulas, and Reactions
4	G	005	Phases of Matter and Kinetic Molecular Theory
5	C	003	Nomenclature, Chemical Formulas, and Reactions
6	F	003	Nomenclature, Chemical Formulas, and Reactions
7	C	005	Phases of Matter and Kinetic Molecular Theory
8	G	003	Nomenclature, Chemical Formulas, and Reactions
9	A	001	Scientific Investigation
10	G	005	Phases of Matter and Kinetic Molecular Theory
11	C	002	Atomic Structure and Periodic Relationships
12	G	001	Scientific Investigation
13	B	002	Atomic Structure and Periodic Relationships
14	H	004	Molar Relationships
15	A	002	Atomic Structure and Periodic Relationships
16	G	001	Scientific Investigation
17	D	004	Molar Relationships
18	F	001	Scientific Investigation
19	C	001	Scientific Investigation
20	J	002	Atomic Structure and Periodic Relationships
21	C	002	Atomic Structure and Periodic Relationships
22	J	003	Nomenclature, Chemical Formulas, and Reactions
23	B	005	Phases of Matter and Kinetic Molecular Theory
24	F	004	Molar Relationships
25	B	003	Nomenclature, Chemical Formulas, and Reactions
26	J	002	Atomic Structure and Periodic Relationships
27	C	001	Scientific Investigation
28	H	004	Molar Relationships
29	B	003	Nomenclature, Chemical Formulas, and Reactions
30	F	001	Scientific Investigation
31	B	004	Molar Relationships
32	G	005	Phases of Matter and Kinetic Molecular Theory
33	C	001	Scientific Investigation
34	G	003	Nomenclature, Chemical Formulas, and Reactions
35	C	004	Molar Relationships
36	G	003	Nomenclature, Chemical Formulas, and Reactions
37	C	003	Nomenclature, Chemical Formulas, and Reactions
38	J	001	Scientific Investigation
39	B	002	Atomic Structure and Periodic Relationships
40	G	003	Nomenclature, Chemical Formulas, and Reactions
41	A	002	Atomic Structure and Periodic Relationships
42	H	005	Phases of Matter and Kinetic Molecular Theory
43	D	005	Phases of Matter and Kinetic Molecular Theory
44	H	003	Nomenclature, Chemical Formulas, and Reactions
45	C	003	Nomenclature, Chemical Formulas, and Reactions
46	F	003	Nomenclature, Chemical Formulas, and Reactions
47	C	004	Molar Relationships
48	J	003	Nomenclature, Chemical Formulas, and Reactions
49	B	005	Phases of Matter and Kinetic Molecular Theory
50	G	004	Molar Relationships