

The University of the State of New York  
REGENTS HIGH SCHOOL EXAMINATION

**PHYSICAL SETTING  
CHEMISTRY**

221 students  
170 passing  
77% pass rate

**Tuesday, June 18, 2013 — 9:15 a.m. to 12:15 p.m., only**

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

This is a test of your knowledge of chemistry. Use that knowledge to answer all questions in this examination. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in this examination booklet.

A separate answer sheet for Part A and Part B-1 has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet. Record your answers to the Part A and Part B-1 multiple-choice questions on this separate answer sheet. Record your answers for the questions in Part B-2 and Part C in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

All answers in your answer booklet should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on your separate answer sheet or in your answer booklet as directed.

When you have completed the examination, you must sign the statement printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice . . .

A four-function or scientific calculator and a copy of the *2011 Edition Reference Tables for Physical Setting/Chemistry* must be available for you to use while taking this examination.

**DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.**

## Part A

Answer all questions in this part.

*Directions (1–30):* For each statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the 2011 Edition Reference Tables for Physical Setting/Chemistry.

- 1 According to the wave-mechanical model of the atom, an orbital is a region of the most probable location of  
2 (1) an alpha particle    210 (3) an electron  
4 (2) a gamma ray        5 (4) a proton
- 2 Which particles have approximately the same mass?  
6 (1) an electron and an alpha particle  
43 (2) an electron and a proton  
4 (3) a neutron and an alpha particle  
168 (4) a neutron and a proton
- 3 During a flame test, a lithium salt produces a characteristic red flame. This red color is produced when electrons in excited lithium atoms  
13 (1) are lost by the atoms  
3 (2) are gained by the atoms  
143 (3) return to lower energy states within the atoms  
62 (4) move to higher energy states within the atoms
- 4 Compared to the energy and charge of the electrons in the first shell of a Be atom, the electrons in the second shell of this atom have  
76 (1) less energy and the same charge  
2 (2) less energy and a different charge  
136 (3) more energy and the same charge  
7 (4) more energy and a different charge
- 5 Which quantity can vary among atoms of the same element?  
140 (1) mass number  
1 (2) atomic number  
19 (3) number of protons  
61 (4) number of electrons
- 6 Which substances have atoms of the same element but different molecular structures?  
1 (1) He(g) and Ne(g)    4 (3) K(s) and Na(s)  
212 (2) O<sub>2</sub>(g) and O<sub>3</sub>(g)    4 (4) P<sub>4</sub>(s) and S<sub>8</sub>(s)
- 7 An atom that has 13 protons and 15 neutrons is an isotope of the element  
13 (1) nickel                    186 (3) aluminum  
14 (2) silicon                    7 (4) phosphorus
- 8 Which elements have the most similar chemical properties?  
15 (1) Si, As, and Te        154 (3) Mg, Sr, and Ba  
49 (2) N<sub>2</sub>, O<sub>2</sub>, and F<sub>2</sub>        1 (4) Ca, Cs, and Cu
- 9 Which list includes three types of chemical formulas for organic compounds?  
9 (1) covalent, metallic, isotopic  
25 (2) covalent, metallic, molecular  
32 (3) empirical, structural, isotopic  
154 (4) empirical, structural, molecular
- 10 In a bond between an atom of carbon and an atom of fluorine, the fluorine atom has a  
36 (1) weaker attraction for electrons  
175 (2) stronger attraction for electrons  
3 (3) smaller number of first-shell electrons  
7 (4) larger number of first-shell electrons
- 11 A sample of CO<sub>2</sub>(s) and a sample of CO<sub>2</sub>(g) differ in their  
8 (1) chemical compositions  
1 (2) empirical formulas  
10 (3) molecular structures  
202 (4) physical properties

12 Which statement defines the temperature of a sample of matter?

- 1 (1) Temperature is a measure of the total electromagnetic energy of the particles.  
40 (2) Temperature is a measure of the total thermal energy of the particles.  
16 (3) Temperature is a measure of the average potential energy of the particles.  
163 (4) Temperature is a measure of the average kinetic energy of the particles.

13 For a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the

- 16 (1) heat of fusion  
139 (2) heat of reaction  
49 (3) activation energy of the forward reaction  
17 (4) activation energy of the reverse reaction

14 Which equation represents sublimation?

- 19 (1)  $\text{Hg}(\ell) \rightarrow \text{Hg}(\text{s})$  18 (3)  $\text{NH}_3(\text{g}) \rightarrow \text{NH}_3(\ell)$   
172 (2)  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g})$  12 (4)  $\text{CH}_4(\ell) \rightarrow \text{CH}_4(\text{g})$

15 Which statement describes the particles of an ideal gas, based on the kinetic molecular theory?

- 17 (1) The motion of the gas particles is orderly and circular.  
180 (2) The gas particles have no attractive forces between them.  
8 (3) The gas particles are larger than the distances separating them.  
16 (4) As the gas particles collide, the total energy of the system decreases.

16 Two grams of potassium chloride are completely dissolved in a sample of water in a beaker. This solution is classified as

- 1 (1) an element  
12 (2) a compound  
181 (3) a homogeneous mixture  
27 (4) a heterogeneous mixture

17 Which compound has the strongest hydrogen bonding between its molecules?

- 7 (1) HBr 163 (3) HF  
29 (2) HCl 21 (4) HI

18 Powdered sulfur is yellow, and powdered iron is gray. When powdered sulfur and powdered iron are mixed at  $20^\circ\text{C}$ , the powdered iron

- 14 (1) becomes yellow 54 (3) remains ionic  
12 (2) becomes a liquid 141 (4) remains magnetic

19 An effective collision between reactant particles requires the particles to have the proper

- 25 (1) charge and mass  
51 (2) charge and orientation  
20 (3) energy and mass  
125 (4) energy and orientation

20 Which term is defined as a measure of the disorder of a system?

- 5 (1) heat 7 (3) kinetic energy  
207 (2) entropy 2 (4) activation energy

21 Which process is used to determine the concentration of an acid?

- 17 (1) chromatography 15 (3) electrolysis  
8 (2) distillation 181 (4) titration

22 The compounds  $\text{CH}_3\text{OCH}_3$  and  $\text{CH}_3\text{CH}_2\text{OH}$  have different functional groups. Therefore, these compounds have different

- 180 (1) chemical properties  
16 (2) gram-formula masses  
11 (3) percent compositions by mass  
13 (4) numbers of atoms per molecule

23 Which term identifies the half-reaction that occurs at the anode of an operating electrochemical cell?

- 181 (1) oxidation 5 (3) neutralization  
31 (2) reduction 4 (4) transmutation

24 During the operation of a voltaic cell, the cell produces

- 123 (1) electrical energy spontaneously  
23 (2) chemical energy spontaneously  
54 (3) electrical energy nonspontaneously  
20 (4) chemical energy nonspontaneously

25 In which type of chemical reaction are electrons transferred?

- 2 (1) organic addition  
187 (2) oxidation-reduction  
27 (3) double replacement  
5 (4) acid-base neutralization

26 A substance that dissolves in water and produces hydronium ions as the only positive ions in the solution is classified as

- 12 (1) an alcohol      40 (3) a base  
139 (2) an acid      29 (4) a salt

27 According to one acid-base theory, a base is an

- 167 (1)  $H^+$  acceptor      8 (3)  $Na^+$  acceptor  
43 (2)  $H^+$  donor      3 (4)  $Na^+$  donor

28 Which compound is an electrolyte?

- 16 (1)  $CCl_4$       58 (3)  $C_6H_{12}O_6$   
35 (2)  $CH_3OH$       111 (4)  $Ca(OH)_2$

29 Which term identifies a type of nuclear reaction?

- 7 (1) fermentation      3 (3) reduction  
4 (2) deposition      207 (4) fission

30 Which radioisotopes have the same decay mode and have half-lives greater than 1 hour?

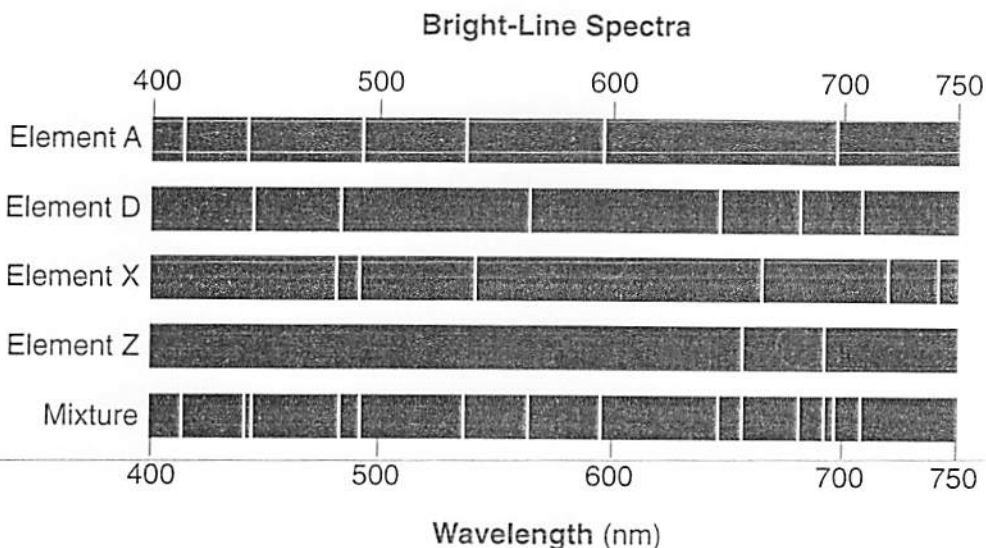
- 4 (1) Au-198 and N-16      197 (3) I-131 and P-32  
10 (2) Ca-37 and Fe-53      10 (4) Tc-99 and U-233

Part B-1

Answer all questions in this part.

Directions (31–50): For each statement or question, record on your separate answer sheet the number of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the 2011 Edition Reference Tables for Physical Setting/Chemistry.

- 31 The diagram below represents the bright-line spectra of four elements and a bright-line spectrum produced by a mixture of three of these elements.



Which element is *not* present in the mixture?

- 2(1) A  
3(2) D

- 197(3) X  
19(4) Z

- 32 What is the overall charge of an ion that has 12 protons, 10 electrons, and 14 neutrons?

- 20(1) 2-                      7(3) 4-  
189(2) 2+                      5(4) 4+

- 33 As the elements in Period 3 are considered in order of increasing atomic number, there is a general *decrease* in

- 5(1) atomic mass  
165(2) atomic radius  
27(3) electronegativity  
24(4) first ionization energy

- 34 Which electron configuration represents the electrons of a sulfur atom in an excited state?

- 11(1) 2-6-6                      7(3) 2-8-4  
183(2) 2-7-7                      20(4) 2-8-6

- 35 Given the word equation:

sodium chlorate → sodium chloride + oxygen

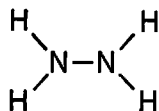
Which type of chemical reaction is represented by this equation?

- 0(1) double replacement    (3) decomposition    188  
8(2) single replacement    (4) synthesis        25

36 Which compound has the highest percent composition by mass of strontium?

- 10 (1) SrCl<sub>2</sub>                      181 (3) SrO  
 27 (2) SrI<sub>2</sub>                        3 (4) SrS

37 Given the formula for hydrazine:



How many pairs of electrons are shared between the two nitrogen atoms?

- 130 (1) 1                              17 (3) 3  
 67 (2) 2                              7 (4) 4

38 Which formulas represent one ionic compound and one molecular compound?

- 20 (1) N<sub>2</sub> and SO<sub>2</sub>                143 (3) BaCl<sub>2</sub> and N<sub>2</sub>O<sub>4</sub>  
 15 (2) Cl<sub>2</sub> and H<sub>2</sub>S                43 (4) NaOH and BaSO<sub>4</sub>

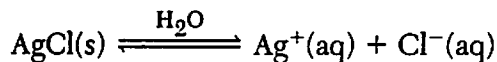
39 Which Kelvin temperature is equal to 200.°C?

- 16 (1) -73 K                        2 (3) 200. K  
 10 (2) 73 K                         199 (4) 473 K

40 A 10.0-gram sample of H<sub>2</sub>O(l) at 23.0°C absorbs 209 joules of heat. What is the final temperature of the H<sub>2</sub>O(l) sample?

- 12 (1) 5.0°C                        157 (3) 28.0°C  
 21 (2) 18.0°C                        30 (4) 50.0°C

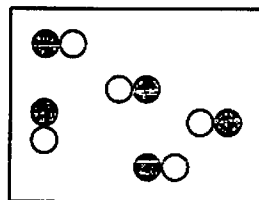
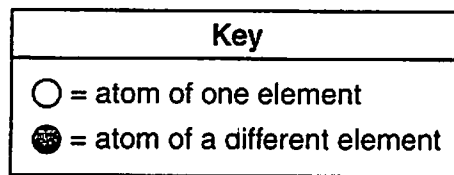
41 Given the equation representing a system at equilibrium:



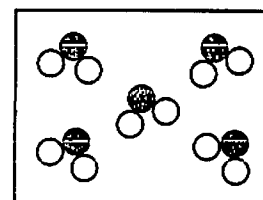
When the concentration of Cl<sup>-</sup>(aq) is increased, the concentration of Ag<sup>+</sup>(aq)

- 116 (1) decreases, and the amount of AgCl(s) increases  
 16 (2) decreases, and the amount of AgCl(s) decreases  
 77 (3) increases, and the amount of AgCl(s) increases  
 12 (4) increases, and the amount of AgCl(s) decreases

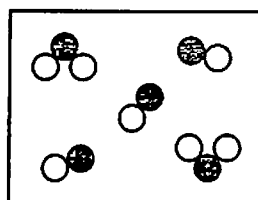
42 Which particle diagram represents a sample of matter that can not be broken down by chemical means?



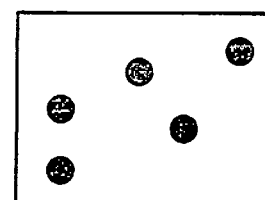
3 (1)



7 (3)

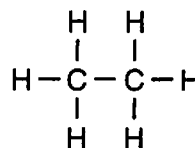


4 (2)

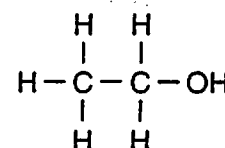


207 (4)

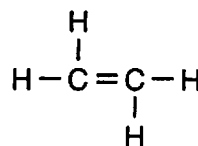
43 Which formula represents an unsaturated hydrocarbon?



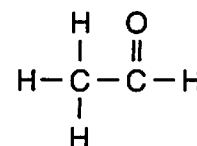
39 (1)



33 (3)



125 (2)



24 (4)

44 When the pH of a solution is changed from 4 to 3, the hydronium ion concentration of the solution

- 68 (1) decreases by a factor of 10  
126 (2) increases by a factor of 10  
16 (3) decreases by a factor of 100  
17 (4) increases by a factor of 100

45 Three samples of the same solution are tested, each with a different indicator. All three indicators, bromthymol blue, bromcresol green, and thymol blue, appear blue if the pH of the solution is

- 10 (1) 4.7                      23 (3) 7.8  
13 (2) 6.0                      175 (4) 9.9

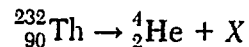
46 A 10.0-milliliter sample of NaOH(aq) is neutralized by 40.0 milliliters of 0.50 M HCl. What is the molarity of the NaOH(aq)?

- 9 (1) 1.0 M                      39 (3) 0.25 M  
156 (2) 2.0 M                      16 (4) 0.50 M

47 Radiation is spontaneously emitted from hydrogen-3 nuclei, but radiation is *not* spontaneously emitted from hydrogen-1 nuclei or hydrogen-2 nuclei. Which hydrogen nuclei are stable?

- 205 (1) nuclei of H-1 and H-2, only  
4 (2) nuclei of H-1 and H-3, only  
7 (3) nuclei of H-2 and H-3, only  
5 (4) nuclei of H-1, H-2, and H-3

48 Given the equation representing a nuclear reaction in which X represents a nuclide:



Which nuclide is represented by X?

- 5 (1)  ${}_{92}^{236}\text{Ra}$                       18 (3)  ${}_{92}^{236}\text{U}$   
166 (2)  ${}_{88}^{228}\text{Ra}$                       32 (4)  ${}_{88}^{228}\text{U}$

49 After decaying for 48 hours,  $\frac{1}{16}$  of the original mass of a radioisotope sample remains unchanged. What is the half-life of this radioisotope?

- 53 (1) 3.0 h                      143 (3) 12 h  
14 (2) 9.6 h                      11 (4) 24 h

50 Which balanced equation represents nuclear fusion?

- 145 (1)  ${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^4\text{He}$   
9 (2)  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$   
45 (3)  ${}_3^6\text{Li} + {}_0^1\text{n} \rightarrow {}_1^3\text{H} + {}_2^4\text{He}$   
22 (4)  $\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$