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To the Teacher:

The Answer Key for the Brief Review in Chemistry provides answers to all of the questions in the book, including the sample Regents Examinations provided in the back of the book.

To determine concepts that might require more intense review, students can take the Diagnostic Tests provided for each topic. The Diagnostic Tests include questions that are not in the book itself, so you will be able to check students’ understanding of some of the concepts in the topic without simply repeating questions they have seen in the book.

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1. The modern model of the atom is based on the work of
   (1) one scientist over a short period of time
   (2) one scientist over a long period of time
   (3) many scientists over a short period of time
   (4) many scientists over a long period of time

2. Which conclusion is based on the “gold foil experiment” and the resulting model of the atom?
   (1) An atom is mainly empty space, and the nucleus has a positive charge.
   (2) An atom is mainly empty space, and the nucleus has a negative charge.
   (3) An atom has hardly any empty space and the nucleus has a positive charge.
   (4) An atom has hardly any empty space and the nucleus has a negative charge.

3. In the wave-mechanical model, an orbital is a region of space where there is
   (1) a high probability of finding an electron
   (2) a high probability of finding a neutron
   (3) a circular path in which electrons are found
   (4) a circular path in which neutrons are found

4. Which group of atomic models is listed in historical order from the earliest to the most recent?
   (1) hard-sphere model, wave-mechanical model, electron shell model
   (2) hard-sphere model, electron-shell model, wave-mechanical model
   (3) electron-shell model, wave-mechanical model, hard sphere model
   (4) electron-shell model, hard sphere model, wave mechanical model

5. Which statement best describes electrons?
   (1) They are positive subatomic particles and are found in the nucleus.
   (2) They are positive subatomic particles and are found surrounding the nucleus.
   (3) They are negative subatomic particles and are found in the nucleus.
   (4) They are negative subatomic particles and are found surrounding the nucleus.

6. Which two particles make up most of the mass of a hydrogen-2 atom?
   (1) electron and proton
   (2) electron and neutron
   (3) proton and neutron
   (4) proton and positron

7. An atom of carbon-12 and an atom of carbon-14 differ in
   (1) atomic number
   (2) nuclear charge
   (3) mass number
   (4) number of electrons

8. What is the charge of the nucleus in an atom of oxygen-17?
   (1) 0
   (2) –2
   (3) +8
   (4) +17

9. Which statement is true about a proton and a neutron?
   (1) They have the same masses and different charges.
   (2) They have the same masses and the same charges.
   (3) They have different masses and the same charges.
   (4) They have different masses and different charges.

10. The atomic mass of an element is the weighted average of the masses of
    (1) its two most abundant isotopes
    (2) its two least abundant isotopes
    (3) all of its naturally occurring isotopes
    (4) all of its radioactive isotopes
11. An electron in an atom moves from the ground state to an excited state when the energy of the electron
(1) decreases  
(2) increases  
(3) remains the same

12. In the calcium atom in the ground state, the electrons that possess the least amount of energy are located in the
(1) first electron shell  
(2) second electron shell  
(3) third electron shell  
(4) fourth electron shell

13. Which electron transition represents a gain of energy?
(1) from 2nd to 3rd shell  
(2) from 2nd to 1st shell  
(3) from 3rd to 2nd shell  
(4) from 3rd to 1st shell

14. How do the energy and the most probable location of an electron in the third shell of an atom compare to the energy and the most probable location of an electron in the first shell of the same atom?
(1) In the third shell, an electron has more energy and is closer to the nucleus.
(2) In the third shell, an electron has more energy and is farther from the nucleus.
(3) In the third shell, an electron has less energy and is closer to the nucleus.
(4) In the third shell, an electron has less energy and is farther from the nucleus.

15. Which of the following represents an electron configuration of an excited chlorine atom?
(1) 2-8-7  
(2) 2-7-8  
(3) 2-8-8  
(4) 1-9-7

16. Which terms are used to identify pure substances?
(1) an element and a mixture  
(2) an element and a compound  
(3) a solution and a mixture  
(4) a solution and a compound

17. Which species represents a chemical compound?
(1) N₂  
(2) NH₄⁺  
(3) Na  
(4) NaHCO₃

18. Which substance can be broken down by a chemical change?
(1) antimony  
(2) carbon  
(3) hexane  
(4) sulfur

19. One similarity between all mixtures and compounds is that both
(1) are heterogeneous  
(2) consist of two or more substances  
(3) are homogeneous  
(4) are heterogeneous

20. A dilute, aqueous potassium nitrate solution is best classified as a
(1) homogeneous compound  
(2) homogeneous mixture  
(3) heterogeneous compound  
(4) heterogeneous mixture

21. Describe, in terms of subatomic particles found in the nucleus, one difference between the nuclei of carbon-12 atoms and the nuclei of carbon-13 atoms.

22. In an investigation, a dripless wax candle is massed and then lighted. As the candle burns, a small amount of liquid wax forms near the flame. After 10 minutes, the candle’s flame is extinguished and the candle is allowed to cool. The cooled candle is massed.
Identify one physical change that takes place in this investigation.

23. Determine the number of neutrons in an atom of Si-29.
1. What is the empirical formula of a compound with the molecular formula $\text{N}_2\text{O}_4$?
   (1) NO  (2) NO$_2$  (3) N$_2$O  (4) N$_2$O$_3$

2. Which polyatomic ion contains the greatest number of oxygen atoms?
   (1) acetate  (3) hydroxide  (2) carbonate  (4) peroxide

3. In which compound is the ratio of metal ions to nonmetal ions 1 to 2?
   (1) calcium bromide  (2) calcium oxide  (3) calcium phosphide  (4) calcium sulfide

4. Which pair of formulas correctly represents a molecular formula and its corresponding empirical formula?
   (1) $\text{C}_2\text{H}_2$ and CH  (3) $\text{C}_4\text{H}_6$ and CH
   (2) $\text{C}_3\text{H}_4$ and $\text{CH}_3$  (4) $\text{C}_5\text{H}_8$ and $\text{C}_2\text{H}_2$

5. Which pair of compounds has the same empirical formula?
   (1) $\text{C}_2\text{H}_2$ and $\text{C}_6\text{H}_6$
   (2) $\text{CH}_3\text{OH}$ and $\text{C}_2\text{H}_5\text{OH}$
   (3) $\text{C}_2\text{H}_6$ and $\text{C}_2\text{H}_2$
   (4) $\text{CH}_3\text{CHO}$ and $\text{CH}_3\text{COOH}$

6. What is the correct IUPAC name for the compound $\text{NH}_4\text{Cl}$?
   (1) nitrogen chloride  (2) nitrogen chloride  (3) ammonium chloride  (4) ammonium chloride

7. What is the chemical formula for sodium sulfate?
   (1) Na$_2$SO$_3$  (3) NaSO$_3$
   (2) Na$_2$SO$_4$  (4) NaSO$_4$

8. What is the IUPAC name for the compound $\text{FeS}$?
   (1) iron (II) sulfate  (3) iron (II) sulfide
   (2) iron (III) sulfate  (4) iron (III) sulfide

9. What is the chemical formula of copper (II) hydroxide?
   (1) CuOH  (3) Cu$_2$OH
   (2) CuOH$_2$  (4) Cu(OH)$_2$

10. What is the correct IUPAC name of (NH$_4$)$_2$SO$_4$?
    (1) ammonium sulfide
    (2) ammonium tetrasulfide
    (3) ammonium sulfite
    (4) ammonium sulfate

11. All chemical reactions have a conservation of
    (1) mass, only
    (2) mass and charge, only
    (3) charge and energy, only
    (4) mass, charge, and energy

12. Which equation shows conservation of atoms?
    (1) $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
    (2) $2\text{H}_2 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O}$
    (3) $\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
    (4) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

13. Which half reaction shows a conservation of charge?
    (1) $\text{Cu} + e^- \rightarrow \text{Cu}^+$
    (2) $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$
    (3) $\text{Cu}^+ \rightarrow \text{Cu} + e^-$
    (4) $\text{Cu}^{2+} \rightarrow \text{Cu} + 2e^-$

14. If an equation is properly balanced, both sides of the equation must have the same number of
    (1) atoms
    (2) coefficients
    (3) molecules
    (4) moles of molecules

15. Given the balanced equation:
    $\text{H}^+(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O}(l) + 55.8 \text{ kJ}$
    In this reaction there is a conservation of
    (1) mass, only
    (2) mass and energy, only
    (3) mass and charge, only
    (4) mass, charge, and energy
16. Given the unbalanced equation: 
\[ \text{Al} + \text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{Cu} \]
When the equation is balanced using the smallest whole-number coefficients, what is the coefficient of Al?
(1) 1  (2) 2  (3) 3  (4) 4

17. Which chemical equation is correctly balanced?
(1) \( \text{H}_2(g) + \text{O}_2(g) \rightarrow \text{H}_2\text{O}(g) \)
(2) \( \text{N}_2(g) + \text{H}_2(g) \rightarrow \text{NH}_3 \)
(3) \( 2\text{NaCl}(s) \rightarrow \text{Na}(s) + \text{Cl}_2(g) \)
(4) \( 2\text{KCl}(s) \rightarrow 2\text{K}(s) + \text{Cl}_2(g) \)

18. Which list includes three types of chemical reactions?
(1) condensation, double replacement, and sublimation
(2) condensation, solidification, and synthesis
(3) decomposition, double replacement, and synthesis
(4) decomposition, double replacement, and sublimation

19. Given the balanced equation:
\[ 2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2 \]
Which type of reaction is represented by this equation?
(1) synthesis
(2) decomposition
(3) single replacement
(4) double replacement

20. Given the balanced equation:
\[ \text{H}_2\text{SO}_4(aq) + 2\text{KOH}(aq) \rightarrow 2\text{H}_2\text{O}(\ell) + \text{K}_2\text{SO}_4 \]
What type of reaction is represented by this equation?
(1) decomposition
(2) neutralization
(3) single replacement
(4) synthesis

21. Given the incomplete equation:
\[ \text{Cr}_2\text{O}_3 + 2\text{Al} \rightarrow \text{____} + 2\text{Cr} \]
What is the formula of the missing product?
(1) Al  (2) AlO  (3) Al_2O_3  (4) Al_3O_2

22. Given the incomplete equation:
\[ 4\text{NH}_3 + 5\text{O}_2 \rightarrow \text{____} + 6\text{H}_2\text{O} \]
What is the formula of the missing product?
(1) N_2  (2) N_2H_4  (3) NO  (4) NO_2

23. Given the equation for the combustion of ethane:
\[ 2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{____} \]
What is the formula of the missing product?
(1) CH_3OH  (2) H_2O
(3) HCOOH  (4) H_2O_2

24. What is the empirical formula of titanium (II) oxide?
(1) TiO  (2) Ti_2O  (3) Y_2O  (4) Ti_2O_3

Given the unbalanced equation:
\[ \text{____C}_6\text{H}_{12}\text{O}_6 \rightarrow \text{____C}_2\text{H}_5\text{OH} + \text{____CO}_2 \]

25. Balance the equation using the lowest whole-number coefficients.
1. The gram formula mass of Ba(OH)\(_2\) is
   (1) 154.3 g  (3) 171.3 g
   (2) 155.3 g  (4) 308.6 g

2. What is the gram formula mass of Ca\(_3\)(PO\(_4\))\(_2\)?
   (1) 248 g  (3) 279 g
   (2) 263 g  (4) 310. g

3. What is the gram formula mass of Mg(ClO\(_3\))\(_2\)?
   (1) 107 g  (3) 174 g
   (2) 142 g  (4) 191 g

4. What is the gram-formula mass of the compound with the formula CH\(_3\)COOH?
   (1) 44.0 g  (3) 191 g
   (2) 60.0 g  (4) 191 g

5. What is the gram formula mass of Ca(HCO\(_3\))\(_2\)?
   (1) 101 g  (3) 202 g
   (2) 162 g  (4) 324 g

6. What is the percent by mass of oxygen in Fe\(_2\)O\(_3\)? (formula mass = 160)
   (1) 16%  (2) 30.%  (3) 56%  (4) 70.%

7. What is the percent by mass of sulfur in sulfur dioxide?
   (1) 32%  (2) 33%  (3) 50.%  (4) 67%

8. The percent by mass of Ca in CaCl\(_2\) is equal to
   (1) 40/111 \times 100  (3) 3/1 \times 100
   (2) 111/40 \times 100  (4) 1/3 \times 100

9. Which species contains the greatest percent by mass of oxygen?
   (1) OH\(^-\)  (2) H\(_2\)O  (3) H\(_3\)O\(^+\)  (4) H\(_2\)O\(_2\)

10. The percent, by mass, of water in BaCl\(_2\) \(\cdot\) 2H\(_2\)O (formula mass = 243) is equal to
    (1) 18/243 \times 100
    (2) 36/243 \times 100
    (3) 243/18 \times 100
    (4) 243/36 \times 100

11. The mass of one mole of nitrogen gas molecules at STP is
    (1) 7 g  (2) 14 g  (3) 16 g  (4) 28 g

12. The mass of 2 moles of sulfur dioxide gas is
    (1) 48.0 g  (3) 80.0 g
    (2) 64.0 g  (4) 128 g

13. What is the total number of moles contained in 115 grams of C\(_2\)H\(_5\)OH?
    (1) 1.0  (2) 1.5  (3) 3.00  (4) 2.50

14. What is the total mass of 0.75 mole of SO\(_2\)?
    (1) 16 g  (2) 24 g  (3) 32 g  (4) 48 g

15. The mass of two moles of sulfuric acid, expressed in grams, is
    (1) 98/2  (3) 2 \times 98
    (2) 98  (4) 4 \times 98

16. A compound with an empirical formula of CH\(_2\) has a molecular mass of 70. What is the molecular formula?
    (1) CH\(_2\)  (2) C\(_2\)H\(_4\)  (3) C\(_4\)H\(_8\)  (4) C\(_5\)H\(_{10}\)

17. A compound has an empirical formula of CH and a molecular mass of 78. What is the molecular formula of the compound?
    (1) C\(_2\)H\(_2\)  (2) C\(_3\)H\(_3\)  (3) C\(_4\)H\(_4\)  (4) C\(_6\)H\(_6\)

18. A compound has an empirical formula of CH\(_2\)O and the molecular mass is 180 amu. What is the molecular formula of this compound?
    (1) C\(_6\)H\(_{12}\)O\(_6\)  (2) C\(_4\)H\(_8\)O\(_4\)
    (3) C\(_2\)H\(_4\)O\(_2\)  (4) CH\(_2\)O

19. A compound with a molecular mass of 34 contains hydrogen and oxygen in a ratio of 1:1. The molecular formula of this compound is
    (1) HO  (2) H\(_2\)O  (3) H\(_2\)O\(_2\)  (4) OH
20. What is the empirical formula of the compound whose molecular formula is C₆H₁₂O₆?
   (1) C₁₂H₂₄O₁₂  (3) C₃H₄O₂
   (2) C₆H₁₂O₆  (4) CH₂O

21. Given the reaction:
    N₂(g) + 3H₂(g) → 2NH₃(g)
What is the mole-to-mole ratio between nitrogen gas and hydrogen gas?
   (1) 1:2  (2) 1:3  (3) 2:2  (4) 2:3

22. Given the balanced equation representing a reaction:
    F₂(g) + H₂(g) → 2HF
What is the mole ratio of H₂(g) to HF(g) in this reaction?
   (1) 1:1  (2) 1:2  (3) 2:1  (4) 2:3

23. Given the equation:
    2C₂H₆(g) + 5O₂(g) → 4CO₂(g) + 2H₂O(g)
How many moles of oxygen are required to react completely with 1.0 mole of C₂H₆?
   (1) 2.5  (2) 2.0  (3) 5.0  (4) 10

24. Given the reaction:
    PbCl₂(aq) + Na₂CrO₄(aq) → PbCrO₄(s) + 2NaCl(aq)
What is the total number of moles of NaCl formed when 2 moles of Na₂CrO₄ react completely?
   (1) 1 mole  (3) 3 moles
   (2) 2 moles  (4) 4 moles

25. Given the balanced equation:
    2C₄H₁₀(g) + 13O₂(g) → 8CO₂(g) + 10H₂O(g)
What is the total number of moles of O₂(g) that must react completely with 5 moles of C₄H₁₀(g)?
   (1) 10.0  (2) 20.0  (3) 26.5  (4) 32.5

26. A compound has an empirical formula of CH₂ and a molecular mass of 56. What is its molecular formula?

27. Sixteen grams of element A combine with 24 grams of oxygen to form an oxide. What is the percentage, by mass, of element A in the oxide?

28. Given the equation:
    (NH₄)₂CO₃ → 2NH₃ + CO₂ + H₂O
What is the minimum number of moles of ammonium carbonate needed to produce 4 moles of ammonia?

29. How many moles are present in 171 grams of Al₂(SO₄)₃?

30. What is the gram formula mass of 0.50 mole of Ca(HCO₃)₂?

31. Vitamin C has an empirical formula of C₃H₄O₃ and a molecular mass of 176. What is its molecular formula?
1. Which statement best describes the shape and volume of an aluminum cylinder at STP?
   (1) It has a definite shape and a definite volume.
   (2) It has a definite shape and no definite volume.
   (3) It has no definite shape and a definite volume.
   (4) It has no definite shape and no definite volume.

2. Which statement correctly describes a sample of gas confined in a sealed container?
   (1) It always has a definite volume, and it takes the shape of the container.
   (2) It takes the shape and the volume of any container in which it is confined.
   (3) It has a crystalline structure.
   (4) It consists of particles arranged in a regular geometric pattern.

3. As a gas condenses, the average distance between its molecules
   (1) decreases
   (2) increases
   (3) remains the same

4. Which process increases the potential energy of the particles of a sample?
   (1) condensation
   (2) deposition
   (3) solidification
   (4) vaporization

5. Which change represents sublimation?
   (1) \( \text{NH}_3(\ell) \rightarrow \text{NH}_3(g) \)
   (2) \( \text{CO}_2(s) \rightarrow \text{CO}_2(g) \)
   (3) \( \text{KI}(s) \rightarrow \text{KI}(\ell) \)
   (4) \( \text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(\ell) \)

6. Which phase change is exothermic?
   (1) freezing of water
   (2) sublimation of water
   (3) boiling of ammonia
   (4) melting of ice

7. At STP, which list of elements contains a solid, a liquid, and a gas?
   (1) Hf, Hg, He
   (2) Cr, Cl\(_2\), Ar
   (3) Ba, Br\(_2\), B
   (4) Se, Sn, Sr

8. Which Kelvin temperature is equivalent to \(-24\,^\circ\text{C}\)?
   (1) 226 K
   (2) 249 K
   (3) 273 K
   (4) 297 K

9. At which Celsius temperature does lead change from a solid to a liquid?
   (1) 874\(^\circ\text{C}\)
   (2) 601\(^\circ\text{C}\)
   (3) 328\(^\circ\text{C}\)
   (4) O\(^\circ\text{C}\)

10. Different masses of samples of helium and neon are at the same temperature. Compared to the average kinetic energy of the sample of helium, the average kinetic energy of the neon is
    (1) greater
    (2) less
    (3) the same

11. When the temperature of a substance rises from 35\(^\circ\text{C}\) to 80\(^\circ\text{C}\), the Kelvin temperature will
    (1) increase by 45 Kelvins
    (2) decrease by 45 Kelvins
    (3) increase by 273 Kelvins
    (4) increase by 318 Kelvins

12. An iron bar at 325 K is placed in a sample of water. The iron bar gains energy from the water when the temperature of the water is
    (1) 65 K
    (2) 45 K
    (3) 65\(^\circ\text{C}\)
    (4) 45\(^\circ\text{C}\)

13. How much heat energy must be absorbed to completely melt 35.0 grams of \(\text{H}_2\text{O}(s)\) at 0\(^\circ\text{C}\)?
    (1) 9.54 J
    (2) 146 J
    (3) 11 700 J
    (4) 79 000 J

14. What amount of heat is required to completely melt a 29.95-gram sample of \(\text{H}_2\text{O}(s)\) at 0\(^\circ\text{C}\)?
    (1) 334 J
    (2) 2260 J
    (3) \(1.00 \times 10^3\) J
    (4) \(1.00 \times 10^4\) J
15. The volume of a gas is 4.00 liters at 293 K and constant pressure. For the volume of the gas to become 3.00 liters, the Kelvin temperature must be equal to

\[
\frac{3.00 \times 293}{4.00} \quad \text{or} \quad \frac{3.00 \times 4.00}{293}
\]

16. A rigid cylinder with a movable piston contains a 2.0 liter sample of neon gas at STP. What is the volume of this sample when its temperature is increased to 30.°C while its pressure is decreased to 90. kilopascals?

17. A gas occupies a volume of 444 mL at 273 K and 79.0 kPa. What is the final Kelvin temperature when the volume of the gas is changed to 1880 mL and the pressure is changed to 38.7 kPa?

18. Which physical property makes it possible to separate the components of crude oil by means of distillation?

19. Recovering the salt from a mixture of salt and water could best be accomplished by

20. Which property makes it possible to separate the oxygen and the nitrogen from a sample of liquefied air?

21. At room temperature, a mixture of sand and water can be separated by

22. When a mixture of water, sand, and salt is filtered, what passes through the filter paper?
1. What determines the order of placement of the elements on the modern Periodic Table?
   (1) atomic number
   (2) atomic mass
   (3) the number of neutrons, only
   (4) the number of protons and neutrons

2. What is the total number of electrons in the valence shell of an atom of aluminum in the ground state?
   (1) 8  (2) 2  (3) 3  (4) 10

3. What is the total number of electrons found in an atom of sulfur?
   (1) 6  (2) 8  (3) 16  (4) 32

4. The nucleus of an atom of K-42 contains
   (1) 19 protons and 23 neutrons
   (2) 19 protons and 42 neutrons
   (3) 20 protons and 19 neutrons
   (4) 20 protons and 42 neutrons

5. What is the total charge of the nucleus of a carbon atom?
   (1) −6  (2) 0  (3) +6  (4) +12

6. In Period 3, from left to right in order, each successive element will
   (1) decrease in electronegativity
   (2) decrease in atomic mass
   (3) increase in number of protons
   (4) increase in metallic character

7. The element in Group 14, Period 3 on the Periodic Table is classified as a
   (1) metal  (3) metalloid
   (2) noble gas  (4) nonmetal

8. As the elements of Group 1 on the Periodic Table are considered in order of increasing atomic radius, the ionization energy of each successive element generally
   (1) decreases
   (2) increases
   (3) remains the same

9. Which trends are observed when the elements in Period 3 on the Periodic Table are considered in order of increasing atomic number?
   (1) The atomic radius decreases and the first ionization energy generally increases.
   (2) The atomic radius decreases and the first ionization energy generally decreases.
   (3) The atomic radius increases and the first ionization energy generally increases.
   (4) The atomic radius decreases and the first ionization energy generally decreases.

10. Which of the following Group 2 elements has the lowest first ionization energy?
    (1) Be  (2) Mg  (3) Ca  (4) Ba

11. Which of these elements has the least attraction for electrons in a chemical bond?
    (1) oxygen  (3) nitrogen
    (2) fluorine  (4) chlorine

12. Based on electronegativity values, which type of elements tends to have the greatest attraction for electrons?
    (1) metals  (3) nonmetals
    (2) metalloids  (4) noble gases

13. Which of these formulas contains the most polar bond?
    (1) H–Br  (2) H–Cl  (3) H–F  (4) H–I

14. Which trends are observed as each of the elements within Group 15 on the Periodic Table is considered in order from top to bottom?
    (1) Their metallic properties decrease and their atomic radii decrease.
    (2) Their metallic properties decrease and their atomic radii increase.
    (3) Their metallic properties increase and their atomic radii decrease.
    (4) Their metallic properties increase and their atomic radii increase.
15. Which list of elements from Group 2 on the Periodic Table is arranged in order of increasing atomic radius?
(1) Be, Mg, Ca  (3) Ba, Ra, Sr
(2) Ca, Mg, Be  (4) Sr, Ra, Ba

16. When the elements in Group 1 are considered in order from top to bottom, each successive element at standard pressure has
(1) a higher melting point and a higher boiling point
(2) a higher melting point and a lower boiling point
(3) a lower melting point and a higher boiling point
(4) a lower melting point and a lower boiling point

17. Which list consists of elements that have the most similar chemical properties?
(1) Mg, A, and Si  (3) K, Al, and Ni
(2) Mg, Ca, and Ba  (4) K, Ca, and Ga

18. Which group on the Periodic Table of the Elements contains elements that react with oxygen to form compounds with the general formula X₂O?
(1) Group 1  (3) Group 14
(2) Group 2  (4) Group 18

19. The element in Period 4 and Group 1 of the Periodic Table would be classified as a
(1) metal  (3) metalloid
(2) nonmetal  (4) noble gas

20. Which of these elements is the best conductor of electricity?
(1) S  (2) N  (3) Br  (4) Ni

21. At STP, an element that is a brittle solid and a poor conductor of heat and electricity could have an atomic number of
(1) 12  (2) 13  (3) 16  (4) 17

22. Which element has both metallic and nonmetallic properties?
(1) Rb  (2) Rn  (3) Si  (4) Sr

23. Which list of elements contains two metalloids?
(1) C, Si, Ge, Sn  (3) C, P, Se, I
(2) As, Bi, Br, Kr  (4) P, Sb, I, Xe

24. Germanium is classified as a
(1) metal  (3) nonmetal
(2) metalloid  (4) noble gas

25. Which group of the periodic table contains atoms with a stable outer electron configuration?
(1) 1  (2) 8  (3) 16  (4) 18

26. Which Period 4 element has the most metallic properties?
(1) As  (2) Br  (3) Ge  (4) Sc
1. Given the balanced equation: 
\[ I + I \rightarrow I_2 \]
Which statement describes the process represented by this equation?
(1) A bond is formed as energy is released.
(2) A bond is formed and energy is absorbed.
(3) A bond is broken as energy is released.
(4) A bond is broken and energy is absorbed.

2. Given the balanced equation: 
\[ Cu + S \rightarrow CuS + \text{energy} \]
Which statement explains why the energy term is written on the right side of the equation?
(1) The compound CuS is composed of two metals.
(2) The compound CuS is composed of two nonmetals.
(3) Energy is absorbed as the bonds of CuS form.
(4) Energy is released as the bonds of CuS form.

3. Given the Lewis electron-dot diagram:
\[ H \cdot \cdot \cdot H \cdot C \cdot H \cdot \cdot \cdot H \]
Which electrons are represented by all of the dots?
(1) The carbon valence electrons, only
(2) The hydrogen valence electrons, only
(3) The carbon and hydrogen valence electrons
(4) All of the carbon and hydrogen electrons

4. Conductivity in a metal results from the metal having
(1) High electronegativity
(2) High ionization energy
(3) Highly mobile protons in the nucleus
(4) Highly mobile electrons in the valence shell

5. Which Lewis electron-dot structure is drawn correctly for the atom it represents?
(1) \( N \)
(2) \( F \)
(3) \( O \)
(4) \( Ne \)

6. The degree of polarity of a chemical bond in a molecule of a compound can be predicted by determining the difference in the
(1) Melting points of the elements in the compound
(2) Densities of the elements in the compound
(3) Electronegativities of the bonded atoms in a molecule of the compound
(4) Atomic masses of the bonded atoms in a molecule of the compound

7. A solid substance is an excellent conductor of electricity. The chemical bonds of this substance are most likely
(1) Ionic, because the valence electrons are shared between atoms
(2) Ionic, because the valence electrons are mobile
(3) Metallic, because the valence electrons are stationary
(4) Metallic, because the valence electrons are mobile

8. Which species does not have a noble gas configuration?
(1) Na
(2) Mg
(3) Ar
(4) S

9. When sodium and fluorine combine to produce the compound NaF, the ions formed have the same electron configuration as atoms of
(1) argon, only
(2) neon, only
(3) both argon and neon
(4) neither argon nor neon
10. Which of the following has the same electron configuration as an atom of helium?
   (1) H\(^-\)   (2) O\(^2-\)   (3) Na\(^+\)   (4) Ca\(^{2+}\)

11. An atom of argon rarely bonds to an atom of another element because an argon atom has
   (1) 8 valence electrons
   (2) 2 electrons in the first shell
   (3) 3 electron shells
   (4) 22 neutrons

12. A barium atom attains a stable electron configuration when it combines with
   (1) one chlorine atom
   (2) two chlorine atoms
   (3) one sodium atom
   (4) two sodium atoms

13. Covalent bonds are formed when electrons are
   (1) transferred from one atom to another
   (2) captured by the nucleus
   (3) mobile within a metal
   (4) shared between two atoms

14. Which formula represents a nonpolar molecule containing polar covalent bonds?
   (1) H\(_2\)O   (2) CCl\(_4\)   (3) NH\(_3\)   (4) H\(_2\)

15. As a bond between a hydrogen atom and a sulfur atom is formed, electrons are
   (1) Shared to form an ionic compound
   (2) Shared to form a covalent compound
   (3) Transferred to form an ionic compound
   (4) Transferred to form a covalent compound

16. Which two substances are covalent compounds?
   (1) C\(_6\)H\(_{12}\)O\(_9\)(s) and KI(s)
   (2) C\(_6\)H\(_{12}\)O\(_6\)(s) and HCl(g)
   (3) KI(s) and NaCl(s)
   (4) NaCl(s) and HCl(g)

17. Which characteristic is a property of molecular substances?
   (1) Good heat conductivity
   (2) Good electrical conductivity
   (3) Low melting point
   (4) High melting point

18. Attractions between molecules can be explained by
   (1) Asymmetrical molecules with nonpolar bonds
   (2) Asymmetrical molecules with polar bonds
   (3) Symmetrical molecules with nonpolar bonds
   (4) Symmetrical molecules with polar bonds

19. Which compound has hydrogen bonding between its molecules?
   (1) CH\(_4\)   (2) CaH\(_2\)   (3) KH   (4) NH\(_3\)

20. Molecules in a sample of NH\(_3\)(\(\ell\)) are held closely together by intermolecular forces
   (1) Existing between ions
   (2) Existing between electrons
   (3) Caused by different numbers of neutrons
   (4) Caused by unequal charge distribution

21. Which substance contains bonds that involved the transfer of electrons from one atom to another?
   (1) CO\(_2\)   (2) NH\(_3\)   (3) KBr   (4) Cl\(_2\)

22. Which change occurs when a barium atom loses two electrons?
   (1) It becomes a negative ion and its radius decreases.
   (2) It becomes a negative ion and its radius increases.
   (3) It becomes a positive ion and its radius decreases.
   (4) It becomes a positive ion and its radius increases.
Diagnostic Test  TOPIC 7

1. As the temperature of a liquid increases, its vapor pressure
   (1) decreases
   (2) increases
   (3) remains the same

2. Hexane (C₆H₁₄) and water do not form a solution. Which statement explains this phenomenon?
   (1) Hexane is polar and water is nonpolar.
   (2) Hexane is ionic and water is polar.
   (3) Hexane is nonpolar and water is polar.
   (4) Hexane is nonpolar and water is ionic.

3. A mixture of crystals of salt and sugar is added to water and stirred until all solids have dissolved. Which statement best describes the resulting mixture?
   (1) The mixture is homogeneous and can be separated by filtration.
   (2) The mixture is homogeneous and cannot be separated by filtration.
   (3) The mixture is heterogeneous and can be separated by filtration.
   (4) The mixture is heterogeneous and cannot be separated by filtration.

4. The solubility of KClO₃(s) in water increases as the
   (1) temperature of the solution increases
   (2) temperature of the solution decreases
   (3) pressure on the solution increases
   (4) pressure on the solution decreases

5. A sample is prepared by completely dissolving 10.0 grams of NaCl in 1.0 liter of H₂O. Which classification best describes this sample?
   (1) homogeneous compound
   (2) homogeneous mixture
   (3) heterogeneous compound
   (4) heterogeneous mixture

6. An unsaturated aqueous solution of NH₃ is at 90°C in 100. grams of water. According to the reference table, how many grams of NH₃ could this unsaturated solution contain?
   (1) 5 g  (2) 10. g  (3) 15 g  (4) 20. g

7. An unsaturated solution is formed when 80.0 grams of a salt is dissolved in 100. grams of water at 40°C. This salt could be
   (1) KCl  (3) NaCl
   (2) KNO₃  (4) NaNO₃

8. A solution contains 35 grams of KNO₃ dissolved in 100 grams of water at 40°C. How much more KNO₃ would have to be added to make it a saturated solution?
   (1) 29 g  (2) 24 g  (3) 12 g  (4) 4 g

9. One hundred grams of water is saturated with NH₄Cl at 50°C. According to Table G, if the temperature is lowered to 10°C, what is the total amount of NH₄Cl that will precipitate?
   (1) 5.0 g  (2) 17 g  (3) 30. g  (4) 50. g

10. Which of the following could be a supersaturated solution at 40°C?
    (1) 50. g of KNO₃
    (2) 38 g of NaCl
    (3) 30 g of KClO₃
    (4) 110. g of NaNO₃

11. How many moles of solute are contained in 200 milliliters of a 1M solution?
    (1) 1  (2) 0.2  (3) 0.8  (4) 200

12. What is the total number of grams of NaI(s) needed to make 1.0 liter of a 0.010 M solution?
    (1) 0.015  (2) 0.15  (3) 1.5  (4) 15
13. If 0.025 grams of Pb(NO₃)₂ is dissolved in 100. grams of H₂O, what is the concentration of the resulting solution, in parts per million?
   (1) 2.5 × 10⁻⁴ ppm  (3) 250 ppm
   (2) 2.5 ppm  (4) 4.0 × 10³ ppm

14. How many moles of KNO₃ must be dissolved in water to make 1.5 liters of a 2.0 M solution?
   (1) 0.50 mol  (3) 3.0 mol
   (2) 2.0 mol  (4) 1.3 mol

15. What is the molarity of a solution of NaOH if 2 liters of the solution contains 4 moles of NaOH?
   (1) 0.5 M  (3) 8 M
   (2) 2 M  (4) 80 M

16. A student wants to prepare a 1.0 liter solution of a specific molarity. The student determines that the mass of the solute needs to be 30. grams. What is the proper procedure to follow?
   (1) Add 30. grams of solute to 1.0 L of solvent.
   (2) Add 30. grams of solute to 970 mL of solvent to make 1.0 L of solution.
   (3) Add 1000. g of solvent to 30. g of solute.
   (4) Add enough solvent to 30. g of solute to make 1.0 L of solution.

17. The freezing point depression of water depends on
   (1) the number of solute particles
   (2) the molecular mass of the solute particles
   (3) the size of the solute particles
   (4) the phase of the solute before addition to the water

18. Which of the following would have the greatest effect on the freezing point depression of 1 liter of water?
   (1) 1 mole of NaCl
   (2) 1 mole of CaCl₂
   (3) 1 mole of C₆H₁₂O₆
   (4) 1 mole of CH₃OH

19. At standard pressure when NaCl is added to water, the solution will have a
   (1) higher freezing point and a lower boiling point
   (2) higher freezing point and a higher boiling point
   (3) lower freezing point and a lower boiling point
   (4) lower freezing point and a higher boiling point

20. What occurs when NaCl(s) is added to water?
   (1) The boiling point increases and the freezing point decreases.
   (2) The boiling point increases and the freezing point increases.
   (3) The boiling point decreases and the freezing point decreases.
   (4) The boiling point decreases and the freezing point increases.

21. Which solution has the lowest freezing point?
   (1) 10. g of KI dissolved in 100. g of water
   (2) 20. g of KI dissolved in 200. g of water
   (3) 30. g of KI dissolved in 100. g of water
   (4) 40. g of KI dissolved in 200. g of water

22. The vapor pressure of a liquid is 0.92 atm at 60°C. The normal boiling point of the liquid could be
   (1) 35°C  (2) 45°C  (3) 55°C  (4) 65°C

23. The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the pressure on the surface of the liquid. What is the boiling point of propanone if the pressure on its surface is 48kPa?
   (1) 25°C  (2) 30.°C  (3) 35°C  (4) 40.°C

24. Which substance has the lowest vapor pressure at 75°C?
   (1) water  (3) propanone
   (2) ethanoic acid  (4) ethanol
1. The kinetic molecular theory assumes that the particles of an ideal gas
   (1) are in random, constant straight-line motion
   (2) are arranged in a regular geometric pattern
   (3) have strong attractive forces between them
   (4) have collisions that result in the system losing energy

2. Which expression represents the $\Delta H$ for a chemical reaction in terms of the potential energy, PE, of its products and reactants?
   (1) $\text{PE of products} + \text{PE of reactants}$
   (2) $\text{PE of products} - \text{PE of reactants}$
   (3) $\text{PE of products} \times \text{PE of reactants}$
   (4) $\text{PE of products} \div \text{PE of reactants}$

3. Increasing the temperature increases the rate of a reaction by
   (1) lowering the activation energy
   (2) increasing the activation energy
   (3) lowering the frequency of effective collisions between reacting particles
   (4) increasing the frequency of effective collisions between reacting particles

4. A real gas molecule behaves more like an ideal gas when the gas molecules are
   (1) close and have strong attractive forces between them
   (2) close and have weak attractive forces between them
   (3) far apart and have strong attractive forces between them
   (4) far apart and have weak attractive forces between them

5. In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is defined as the
   (1) activation
   (2) ionization energy
   (3) heat of reaction
   (4) heat of vaporization

6. Which interval on this diagram represents the difference between the potential energy of the products and the potential energy of the reactants?
   (1) 1  (2) 2  (3) 3  (4) 4

7. Which arrow represents the activation energy of the forward reaction?
   (1) 1  (2) 2  (3) 3  (4) 4

8. How is a chemical reaction affected by the addition of a catalyst?
   (1) The activation energy decreases.
   (2) The heat of reaction increases.
   (3) The number of collisions between particles decreases.
   (4) The potential energy of the reactants increases.

9. Which statement must be true for any chemical reaction at equilibrium?
   (1) The concentration of the products is greater than the concentration of the reactants.
   (2) The concentration of the products is less than the concentration of the reactants.
   (3) The concentration of the products and the concentration of the reactants are equal.
   (4) The concentration of the products and the concentration of the reactants are constant.
10. Which balanced equation represents a phase equilibrium?
   (1) \( \text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g) \)
   (2) \( 2\text{NO}_2(g) \rightleftharpoons \text{N}_2\text{O}_4(g) \)
   (3) \( \text{Cl}_2(g) \rightleftharpoons \text{Cl}_2(l) \)
   (4) \( 3\text{O}_2(g) \rightleftharpoons 2\text{O}_3(g) \)

11. Which statement best describes how a catalyst increases the rate of a reaction?
   (1) The catalyst provides an alternate reaction pathway with a higher activation energy.
   (2) The catalyst provides an alternate reaction pathway with a lower activation energy.
   (3) The catalyst provides the same reaction pathway with a higher activation energy.
   (4) The catalyst provides the same reaction pathway with a lower activation energy.

12. Given the reaction:
   \( \text{AgCl}(s) \rightleftharpoons \text{Ag}^+(aq) + \text{Cl}^-(aq) \)
   Once equilibrium is reached, which statement is true?
   (1) The concentration of \( \text{Ag}^+(aq) \) is greater than the concentration of \( \text{Cl}^-(aq) \).
   (2) The \( \text{AgCl}(s) \) will be completely consumed.
   (3) The rates of the forward and reverse reactions are equal.
   (4) The entropy of the forward reaction will continue to decrease.

13. In terms of energy and entropy, systems in nature tend to undergo changes toward
   (1) higher energy and higher entropy
   (2) higher energy and lower entropy
   (3) lower energy and higher entropy
   (4) lower energy and lower entropy

14. Which 1-mole sample has the least entropy?
   (1) \( \text{Br}_2(s) \) at 266K (3) \( \text{Br}_2(l) \) at 332K
   (2) \( \text{Br}_2(l) \) at 266K (4) \( \text{Br}_2(g) \) at 332K

15. Given the equation:
   \( \text{KNO}_3(s) \rightarrow \text{KNO}_3(aq) \)
   As \( \text{H}_2\text{O} \) is added to \( \text{KNO}_3(s) \) to form \( \text{KNO}_3(aq) \), the entropy of the system
   (1) decreases
   (2) increases
   (3) remains the same

16. Even though the reaction is endothermic, snow can sublime. Which tendency in nature accounts for this phase change?
   (1) a tendency toward greater entropy
   (2) a tendency toward greater energy
   (3) a tendency toward less entropy
   (4) a tendency toward less energy

17. Given the equation representing a reaction at equilibrium:
   \( \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) + 91.8 \text{ kJ} \)
   Which change causes the equilibrium to shift to the right?
   (1) decreasing the concentration of \( \text{H}_2(g) \)
   (2) decreasing the pressure
   (3) increasing the concentration of \( \text{N}_2(g) \)
   (4) increasing the temperature

18. Given the reaction at equilibrium:
   \( \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) + 91.8 \text{ kJ} \)
   What occurs when the concentration of \( \text{H}_2(g) \) is increased?
   (1) The rate of the forward reaction increases and the concentration of \( \text{N}_2(g) \) decreases.
   (2) The rate of the forward reaction decreases and the concentration of \( \text{N}_2(g) \) increases.
   (3) The rate of the forward reaction and the concentration of \( \text{N}_2(g) \) both increase.
   (4) The rate of the forward reaction and the concentration of \( \text{N}_2(g) \) both decrease.
1. Which particles are lost or gained during an oxidation-reduction reaction?
(1) electrons (3) protons
(2) neutrons (4) positrons

2. Which change occurs when Pt\(^{2+}\) is reduced?
(1) The Pt\(^{2+}\) gains electrons and its oxidation number increases.
(2) The Pt\(^{2+}\) gains electrons and its oxidation number decreases.
(3) The Pt\(^{2+}\) loses electrons and its oxidation number increases.
(4) The Pt\(^{2+}\) loses electrons and its oxidation number decreases.

3. Given the equation:
\[ \text{C}(s) + \text{H}_2\text{O}(g) \rightarrow \text{CO}(g) + \text{H}_2(g) \]
Which species undergoes reduction?
(1) \(\text{C}(s)\) (3) \(\text{C}^{2+}\)
(2) \(\text{H}^+\) (4) \(\text{H}_2(g)\)

4. Given the balanced equation:
\[ \text{Zn}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu}(s) \]
Which equation correctly represents oxidation?
(1) \(\text{Zn}(s) + 2\text{e}^- \rightarrow \text{Zn}^{2+}(aq)\)
(2) \(\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2\text{e}^-\)
(3) \(\text{Cu}^{2+}(aq) \rightarrow \text{Cu}(s) + 2\text{e}^-\)
(4) \(\text{Cu}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Cu}(s)\)

5. Which type of reaction occurs when nonmetal atoms become negatively charged ions?
(1) oxidation (3) substitution
(2) reduction (4) condensation

6. When a neutral atom undergoes oxidation, the atom’s oxidation state
(1) decreases as it gains electrons
(2) decreases as it loses electrons
(3) increases as it gains electrons
(4) increases as it loses electrons

7. What is the oxidation state of nitrogen in NaNO\(_2\)?
(1) +1 (2) +2 (3) +3 (4) +4

8. What is the oxidation number of chromium in K\(_2\)Cr\(_2\)O\(_7\)?
(1) +12 (2) +2 (3) +3 (4) +6

9. What is the oxidation number of chromium in the chromate ion, CrO\(_4^{2-}\)?
(1) +6 (2) +2 (3) +3 (4) +8

10. In which substance does chlorine have an oxidation number of +1?
(1) Cl\(_2\) (3) HClO
(2) HCl (4) HClO\(_2\)

11. What is the oxidation number assigned to manganese in KMnO\(_4\)?
(1) +7 (2) +2 (3) +3 (4) +4

12. Which balanced equation represents an oxidation-reduction reaction?
(1) \(\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}\)
(2) \(\text{Ca} + \text{H}_2\text{O} \rightarrow \text{CaO} + \text{H}_2\)
(3) \(\text{CaCO}_3 \rightarrow \text{CaO} + \text{H}_2\text{O}\)
(4) \(\text{Mg(OH)}_2 + 2\text{HNO}_3 \rightarrow 2\text{H}_2\text{O} + \text{Mg(NO}_3)_2\)

13. In which reaction are electrons transferred from one reactant to another reactant?
(1) \(2\text{Ca}(s) + \text{O}_2(g) \rightarrow 2\text{CaO}(s)\)
(2) \(\text{AgNO}_3(aq) + \text{KCl}(aq) \rightarrow \text{AgCl}(s) + \text{KNO}_3(aq)\)
(3) \(\text{HCl}(aq) + \text{NaOH}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l)\)
(4) \(\text{H}_3\text{O}^+(aq) + \text{OH}^-(aq) \rightarrow 2\text{H}_2\text{O}(l)\)

14. Given the balanced ionic equation representing a reaction:
\[ 2\text{Al}^{3+}(aq) + 3\text{Mg}(s) \rightarrow 3\text{Mg}^{2+} + 2\text{Al}(s) \]
In this reaction, electrons are transferred from
(1) Al to Mg\(^{2+}\) (3) Mg to Al\(^{3+}\)
(2) Al\(^{3+}\) to Mg (4) Mg\(^{2+}\) to Al
15. Given the balanced equation representing a redox reaction:
   \[ 2\text{Al} + 3\text{Cu}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Cu} \]
Which statement is true about this reaction?
(1) Each Al loses 2e\(^-\) and each Cu\(^{2+}\) gains 3e\(^-\).
(2) Each Al loses 3e\(^-\) and each Cu\(^{2+}\) gains 2e\(^-\).
(3) Each Al\(^{3+}\) gains 2e\(^-\) and each Cu loses 3e\(^-\).
(4) Each Al\(^{3+}\) gains 3e\(^-\) and each Cu loses 2e\(^-\).

16. Given the unbalanced ionic equation:
   \[ 3\text{Mg(s)} + \underline{\text{Fe}^{3+}} \rightarrow 3\text{Mg}^{2+} + \underline{\text{Fe}} \]
When the equation is balanced, both Fe\(^{3+}\) and Fe have a coefficient of
(1) 1, because a total of 6 electrons is transferred
(2) 2, because a total of 6 electrons is transferred
(3) 1, because a total of 3 electrons is transferred
(4) 1, because a total of 6 electrons is transferred

17. A reduction half-reaction shows
(1) the gain of electrons
(2) the loss of electrons
(3) both the gain and loss of electrons
(4) neither the gain nor the loss of electrons

18. Which half-reaction shows conservation of charge?
(1) \(\text{Cu} + e^- \rightarrow \text{Cu}^+\)
(2) \(\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}\)
(3) \(\text{Cu}^+ \rightarrow \text{Cu} + e^-\)
(4) \(\text{Cu}^{2+} \rightarrow \text{Cu} + 2e^-\)

19. Half-reactions can be written to represent all
(1) double replacement reactions
(2) neutralization reactions
(3) fission and fusion reactions
(4) oxidation and reduction reactions

20. Given the reaction for the corrosion of aluminum:
   \[ 4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \]
Which half-reaction correctly represents the oxidation that occurs?
(1) \(\text{Al} + 3e^- \rightarrow \text{Al}^{3+}\)
(2) \(\text{Al} \rightarrow \text{Al}^{3+} + 3e^-\)
(3) \(\text{O}_2 + 4e^- \rightarrow 2\text{O}^{2-}\)
(4) \(\text{O}_2 \rightarrow 2\text{O}^{2-} + 4e^-\)

21. Which conversion of energy always occurs in a voltaic cell?
(1) light energy to chemical energy
(2) electrical energy to chemical energy
(3) chemical energy to light energy
(4) chemical energy to electrical energy

22. Which energy conversion occurs during the operation of a voltaic cell?
(1) Chemical energy is spontaneously converted to electrical energy
(2) Chemical energy is converted to electrical energy only when an external power source is provided.
(3) Electrical energy is spontaneously converted to chemical energy.
(4) Electrical energy is converted to chemical energy only when an external power source is provided.

23. Given the balanced equation representing the reaction occurring in a voltaic cell
   \[ \text{Zn(s)} + \text{Pb}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + 2\text{Pb}(s) \]
In the completed external circuit, the electrons flow from
(1) \(\text{Pb}(s)\) to \(\text{Zn}(s)\)
(2) \(\text{Pb}^{2+}(aq)\) to \(\text{Zn}^{2+}(aq)\)
(3) \(\text{Zn}(s)\) to \(\text{Pb}(s)\)
(4) \(\text{Zn}^{2+}(aq)\) to \(\text{Pb}^{2+}(aq)\)

24. Which process occurs at the cathode in an electrochemical cell?
(1) the loss of protons
(2) the gain of protons
(3) the gain of electrons
(4) the loss of electrons
1. An H\(^+\) ion, in aqueous solution may also be written as
   (1) H\(_2\)O \hspace{1cm} (2) H\(_2\)O\(_2\) \hspace{1cm} (3) H\(_3\)O\(^+\) \hspace{1cm} (4) \text{OH}^- \\

2. Which formula represents a hydronium ion?
   (1) H\(_3\)O\(^+\) \hspace{1cm} (3) \text{OH}^- \\
   (2) NH\(_4\)\(^+\) \hspace{1cm} (4) \text{HCO}_3^- \\

3. Which ion is the only negative ion present in an aqueous solution?
   (1) hydride ion \hspace{1cm} (3) hydronium ion \\
   (2) hydrogen ion \hspace{1cm} (4) hydroxide ion \\

4. A student tested a 0.1 M aqueous solution and made the following observations:
   • Conducts electricity \\
   • Turns blue litmus red \\
   • Reacts with zinc to produce hydrogen gas bubbles \\
   Which compound could be the solute in this solution?
   (1) CH\(_3\)OH \hspace{1cm} (3) HBr \\
   (2) LiBr \hspace{1cm} (4) LiOH \\

5. Which compound dissolves in water to form an aqueous solution that can conduct an electric current?
   (1) CCl\(_4\) \hspace{1cm} (3) CH\(_3\)COOH \\
   (2) C\(_2\)H\(_5\)OH \hspace{1cm} (4) CH\(_4\) \\

6. An Arrhenius acid has
   (1) only hydroxide ions in solution \\
   (2) only hydrogen ions in solution \\
   (3) hydrogen ions as the only positive ion in solution \\
   (4) hydrogen ions as the only negative ion in solution \\

7. Which substance is an Arrhenius acid?
   (1) LiF(aq) \hspace{1cm} (3) Mg(OH)\(_2\)(aq) \\
   (2) HBr(aq) \hspace{1cm} (4) CH\(_3\)CHO \\

8. Which compound is an Arrhenius base?
   (1) CH\(_3\)OH \hspace{1cm} (3) LiOH \\
   (2) CO\(_2\) \hspace{1cm} (4) NO\(_2\) \\

9. A sample of Ca(OH)\(_2\) is considered to be an Arrhenius base because it dissolves in water to yield
   (1) Ca\(^{2+}\) ions as the only positive ions in solution \\
   (2) H\(_3\)O\(^+\) ions as the only positive ions in solution \\
   (3) \text{OH}^- ions as the only negative ions in solution \\
   (4) H\(^+\) ions as the only negative ions in solution \\

10. The compound HNO\(_3\) can be described as an
    (1) Arrhenius acid and an electrolyte \\
    (2) Arrhenius acid and a nonelectrolyte \\
    (3) Arrhenius base and an electrolyte \\
    (4) Arrhenius base and a nonelectrolyte \\

11. Which species can conduct an electric current?
    (1) NaOH(s) \hspace{1cm} (3) H\(_2\)O(s) \\
    (2) CH\(_3\)OH(aq) \hspace{1cm} (4) HCl(aq) \\

12. Which pair of formulas represents two compounds that are electrolytes?
    (1) HCl and CH\(_3\)OH \\
    (2) HCl and NaOH \\
    (3) C\(_5\)H\(_{12}\) and CH\(_3\)OH \\
    (4) C\(_5\)H\(_{12}\) and NaOH \\

13. Which process uses a volume of solution of known concentration to determine the concentration of another solution?
    (1) distillation \hspace{1cm} (3) transmutation \\
    (2) substitution \hspace{1cm} (4) titration \\

14. Which reaction occurs when hydrogen ions react with hydroxide ions to form water?
    (1) substitution \hspace{1cm} (3) ionization \\
    (2) oxidation \hspace{1cm} (4) neutralization \\

15. A student neutralized 16.4 mLs of HCl acid by adding 12.7 mLs of 0.620 KOH. What was the molarity of the HCl acid?
    (1) 0.168 \hspace{1cm} (3) 0.620 \\
    (2) 0.480 \hspace{1cm} (4) 0.801
16. Which equation represents a neutralization equation?
   (1) Na₂CO₃ + CaCl₂ → 2NaCl + CaCO₃
   (2) Ni(NO₃)₂ + H₂S → NiS + 2HNO₃
   (3) NaCl + AgNO₃ → AgCl + NaNO₃
   (4) H₂SO₄ + Mg(OH)₂ → 2H₂O + MgSO₄

17. Which compound could serve as a reactant in a neutralization reaction?
   (1) NaCl  (3) CH₃OH
   (2) KOH  (4) CH₃CHO

18. Which reactants form the salt CaSO₄(s) in a neutralization reaction?
   (1) H₂S(g) and Ca(ClO₄)₂(s)
   (2) H₂SO₃(aq) and Ca(NO₃)₂(aq)
   (3) H₂SO₄(aq) and Ca(OH)₂(aq)
   (4) SO₂(g) and CaO(s)

19. Which of the following is the salt formed by the neutralization of calcium hydroxide by nitric acid?
   (1) calcium nitride
   (2) calcium nitrate
   (3) calcium nitroxide
   (4) nitro calcide

20. When the pH of a solution changes from a pH of 5 to a pH of 3, the hydronium ion concentration is
   (1) 0.01 of the original content
   (2) 0.1 of the original content
   (3) 10 times the original content
   (4) 100 times the original content

21. Which pH indicates a basic solution?
   (1) 1  (2) 5  (3) 7  (4) 12

22. Which of these 1M solutions will have the highest pH?
   (1) NaOH  (3) HCl
   (2) CH₃OH  (4) NaCl

23. Which of these pH numbers indicates the highest level of acidity?
   (1) 5  (2) 8  (3) 10  (4) 12

24. Given the following solutions:
   Solution A: pH of 10
   Solution B: pH of 7
   Solution C: pH of 5
   Which list has the solutions placed in order of increasing H⁺ concentrations?
   (1) A, B, C  (3) C, A, B
   (2) B, A, C  (4) C, B, A

25. Solution A has a pH of 3 and solution Z has a pH of 6. How many times greater is the hydronium ion concentration in Solution A than the hydronium ion concentration in Solution Z?
   (1) 100  (2) 2  (3) 3  (4) 1000

26. A compound whose water solution conducts electricity and turns phenolphthalein pink is
   (1) HCl  (3) NaOH
   (2) HC₂H₃O₂  (4) CH₃OH

27. According to Reference Table M, what is the color of the indicator methyl orange in a solution that has a pH of 2?
   (1) blue  (2) yellow  (3) orange  (4) red

28. In which solution will a thymol blue indicator appear blue?
   (1) 0.1 M CH₃COOH
   (2) 0.1 M KOH
   (3) 0.1 M HCl
   (4) 0.1 M H₂SO₄

29. Which indicator is yellow in a solution with a pH of 9.8?
   (1) methyl orange
   (2) bromthymol blue
   (3) bromcresol green
   (4) thymol blue

30. One acid-base theory states that an acid is
   (1) an electron donor
   (2) a neutron donor
   (3) an H⁺ donor
   (4) an OH⁻ donor
Diagnostic Test  TOPIC 11

1. All organic compounds must contain the element
   (1) phosphorus (3) carbon
   (2) oxygen (4) nitrogen

2. In saturated hydrocarbons, carbon atoms are bonded to each other by
   (1) single covalent bonds, only
   (2) double covalent bonds, only
   (3) alternating single and double covalent bonds
   (4) alternating double and triple covalent bonds

3. The multiple covalent bond in a molecule of 1-butene is a
   (1) double covalent bond that has 6 shared electrons
   (2) double covalent bond that has 4 shared electrons
   (3) triple covalent bond that has 6 shared electrons
   (4) triple covalent bond that has 4 shared electrons

4. Given the formula: C₄H₂. What is the total number of electrons shared between the two carbon atoms?
   (1) 6 (2) 2 (3) 3 (4) 4

5. Which compound is unsaturated?
   (1) 2-methylbutane (3) 2-hexanol
   (2) 2 chloropropane (4) 2-pentene

6. Which organic compound is a saturated compound?
   (1) ethyne (3) ethanol
   (2) ethene (4) ethane

7. A double carbon-carbon bond is found in a molecule of
   (1) pentane (3) pentyne
   (2) pentene (4) pentanol

8. Which compound is an isomer of pentane?
   (1) butane (3) methyl butane
   (2) propane (4) methyl propane

9. Which two compounds have the same molecular formula but different chemical and physical properties?
   (1) CH₃CH₂Cl and CH₃CH₂Br
   (2) CH₃CHCH₂ and CH₃CH₂CH₃
   (3) CH₃CHO and CH₃COCH₃
   (4) CH₃CH₂OH and CH₃OCH₃

10. Which general formula represents the homologous series of hydrocarbons that includes the compound 1-heptyne?
    (1) CₙHₙ₋₆ (3) CₙH₂₆
    (2) CₙH₂₆₋₂ (4) CₙH₂₆₊₂

11. The three isomers of pentane have different
    (1) formula masses
    (2) molecular formulas
    (3) empirical formulas
    (4) structural formulas

12. A molecule of a compound contains a total of 10 hydrogen atoms and has the general formula CₙH₂₆. Which prefix is used in the name of this compound?
    (1) but- (3) oct-
    (2) dec- (4) pent-

13. Which class of organic compounds has molecules that contain nitrogen atoms?
    (1) alcohol (3) ether
    (2) amine (4) ketone

14. Given the structural formula:
    \[
    \begin{array}{c}
    H \\
    \text{C=C} \\
    H \\
    \text{H} \\
    \text{H}
    \end{array}
    \]
    What is the IUPAC name for this compound?
    (1) propane (3) propanone
    (2) propene (4) propanal

15. The functional group –COOH is found in
    (1) esters (3) alcohols
    (2) aldehydes (4) organic acids
16. Which compound is an alcohol?
   (1) propanal  (3) butane
   (2) ethyne     (4) methanol

17. Which type of organic compound is represented by the structural formula shown below?

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{H} \]

   (1) aldehyde  (3) ether
   (2) alcohol    (4) ester

18. In which reaction is soap a product?
   (1) addition  (3) saponification
   (2) substitution  (4) polymerization

19. Which formula correctly represents the product of an addition reaction between ethene and chlorine?

   (1) CH₂Cl₂  (3) C₆H₄Cl₂
   (2) CH₃Cl    (4) C₂H₃Cl

20. Given the equation:
    \[ \text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl} \]
    This reaction is best described as
    (1) addition involving a saturated hydrocarbon
    (2) addition involving an unsaturated hydrocarbon
    (3) substitution involving a saturated hydrocarbon
    (4) substitution involving an unsaturated hydrocarbon

21. Given the balanced equation for an organic reaction:
    \[ \text{C}_2\text{H}_2 + 2\text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl}_2 \]
    This reaction is classified as
    (1) addition  (3) fermentation
    (2) esterification  (4) substitution

22. The organic compound represented by the condensed structural formula
    \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} \] is classified as an
    (1) alcohol  (3) ester
    (2) aldehyde  (4) ether

23. Which structural formula correctly represents a hydrocarbon molecule?

\[ \begin{align*}
\text{(1)} & \quad \text{H} - \text{C} - \text{H} \\
\text{(3)} & \quad \text{H} - \text{C} - \text{C} - \text{O} \\
\text{(2)} & \quad \text{H} - \text{C} - \text{H} \\
\text{(4)} & \quad \text{H} - \text{C} - \text{C} - \text{H}
\end{align*} \]

24. What is the IUPAC name of the compound with the following structural formula?

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{H} \]

   (1) propanone  (3) butanone
   (2) propanal    (4) butanal

25. Given the structural formula:

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{OH} \]

   This structural formula represents a molecule of
   (1) an aldehyde  (3) a ketone
   (2) an ester     (4) an amino acid

26. Given the formula:

\[ \begin{align*}
\text{(1)} & \quad \text{2-pentene} \\
\text{(3)} & \quad \text{2-butene} \\
\text{(2)} & \quad \text{2-pentyne} \\
\text{(4)} & \quad \text{2-butyne}
\end{align*} \]

   What is the IUPAC name of this compound?
1. For most atoms with an atomic number less than 20, nuclear stability occurs when the ratio of neutrons to protons is 1:1. Which of the following atoms would be most likely to have an unstable nucleus?
   (1) $^{4}_2$He  (3) $^{16}_7$N
   (2) $^{12}_6$C  (4) $^{24}_{12}$Mg

2. Which equation represents a transmutation reaction?
   (1) $^{239}_{92}$U $\rightarrow$ $^{239}_{92}$U $+ \, ^0_0$Y
   (2) $^{14}_6$C $\rightarrow$ $^{14}_7$N $+ \, ^0_0$e
   (3) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
   (4) $nC_2H_2 \rightarrow (-C_2H_4 -)_n$

3. Which equation represents natural nuclear decay?
   (1) $H^+ + OH^- \rightarrow H_2O$
   (2) $KClO_3 \rightarrow K^+ + ClO_3^-$
   (3) $^{235}_{92}$U $\rightarrow$ $^4_2$He $+ \, ^{231}_{90}$Th
   (4) $^{14}_7$N $+ \, ^4_2$He $\rightarrow$ $^{17}_8$O $+ \, ^1_1$H

4. Which type of radioactive emission has a positive charge and a weak penetrating power?
   (1) alpha particle  (3) gamma ray
   (2) beta particle  (4) neutron

5. Alpha particles and beta particles differ in
   (1) mass, only
   (2) charge, only
   (3) both charge and mass
   (4) neither mass nor charge

6. In the reaction $^{239}_{93}$Np $\rightarrow$ $^{239}_{94}$Pu $+ X$, what does $X$ represent?
   (1) a neutron  (3) an alpha particle
   (2) a proton  (4) a beta particle

7. Which equation represents the radioactive decay of Ra-226?
   (1) Ra-226 $\rightarrow$ Rn-222 $+ \, ^4_2$He
   (2) Ra-226 $\rightarrow$ Ac-226 $+ \, ^0_0$e
   (3) Ra-226 $\rightarrow$ Fr-226 $+ \, ^0_0$e
   (4) Ra-226 $\rightarrow$ Ra-225 $+ \, ^0_0$n

8. Which equation represents a positron decay?
   (1) $^{87}_{37}$Rb $\rightarrow$ $^0_0$e $+ \, ^{87}_{38}$Sr
   (2) $^{227}_{92}$U $\rightarrow$ $^{229}_{90}$Th $+ \, ^4_2$He
   (3) $^{27}_{13}$Al $+ \, ^4_2$He $\rightarrow$ $^{30}_{15}$P $+ \, ^0_0$n
   (4) $^{14}_7$C $\rightarrow$ $^0_0$e $+ \, ^{11}_5$B

9. Which list of radioisotopes contains an alpha emitter, a beta emitter, and a positron emitter?
   (1) C-14, N-16, P-32
   (2) Cs-137, Fr-220, Tc-99
   (3) Kr-85, Ne-19, Rn-222
   (4) Pu-239, Th-232, U-238

10. Which isotope will spontaneously decay and emit particles with a charge of +2?
    (1) Fe-53  (3) Au-198
    (2) Cs-137  (4) Fr-220

11. Given the nuclear reaction: $^{60}_{27}$Co $\rightarrow$ $^0_0$e $+ \, ^{60}_{28}$Ni
    This reaction is an example of
    (1) fission
    (2) fusion
    (3) artificial transmutation
    (4) natural transmutation

12. The energy released by a nuclear reaction results primarily from the
    (1) breaking of bonds between atoms
    (2) formation of bonds between atoms
    (3) conversion of mass into energy
    (4) conversion of energy into mass
13. Which reaction is an example of natural transmutation?
   (1) $^{239}_{94}Pu \rightarrow ^{235}_{92}U + ^4_2He$
   (2) $^{27}_{13}Al + ^4_2He \rightarrow ^{30}_{15}Si + ^0_1n$
   (3) $^{238}_{92}U + ^1_0n \rightarrow ^{239}_{94}Pu + ^2_0e$
   (4) $^{239}_{94}Pu + ^1_0n \rightarrow ^{147}_{56}Ba + ^{90}_{38}Sr + ^3_0n$

14. Radioactive cobalt-60 is used in radiation therapy treatment. Cobalt-60 undergoes beta decay. This type of nuclear reaction is called
   (1) natural transmutation
   (2) artificial transmutation
   (3) nuclear fusion
   (4) nuclear fission

15. Which equation represents a fusion reaction?
   (1) $H_2O(g) \rightarrow H_2O(l)$
   (2) $C(s) + O_2(g) \rightarrow CO_2(g)$
   (3) $^2H + ^2H \rightarrow ^4He + ^0_1n$
   (4) $^{235}_{92}U + ^1_0n \rightarrow ^{147}_{56}Ba + ^{91}_{36}Kr + ^3_0n$

16. Nuclear fusion differs from nuclear fission because nuclear fusion reactions
   (1) form heavier isotopes from lighter ones
   (2) form lighter isotopes from heavier ones
   (3) convert mass to energy
   (4) convert energy to mass

17. A nuclear fission reaction and a nuclear fusion reaction are similar because both reactions
   (1) form heavy nuclei from light nuclides
   (2) form light nuclei from heavy nuclides
   (3) release a large amount of energy
   (4) absorb a large amount of energy

18. How many days are required for 200. grams of radon-222 to decay to 50.0 grams?
   (1) 1.91 days
   (2) 3.82 days
   (3) 7.64 days
   (4) 11.5 days

19. Which change takes place in a nuclear fusion reaction?
   (1) Matter is converted to energy.
   (2) Energy is converted to matter.
   (3) Ionic bonds are converted to covalent bonds.
   (4) Covalent bonds are converted to ionic bonds.

20. If 1/8 of an original sample of krypton-74 remains unchanged after 34.5 minutes, what is the half-life of krypton-74?
   (1) 11.5 min
   (2) 23.0 min
   (3) 34.5 min
   (4) 46.0 min

21. Based on Reference Table N, what fraction of a sample of gold-198 remains radioactive after 2.69 days?
   (1) 1/4
   (2) 1/2
   (3) 3/4
   (4) 7/8

22. An original sample of K-40 has a mass of 25.00 grams. After $3.9 \times 10^9$ years, 3.125 grams of the original sample remains unchanged. What is the half-life of K-40?
   (1) $1.3 \times 10^8y$
   (2) $2.6 \times 10^8y$
   (3) $3.9 \times 10^8y$
   (4) $1.2 \times 10^{10}y$

23. Given 1.00 gram of each of the following radioisotopes, Ca-37, U-238, P-32, and Rn-222, which would have the least remaining original isotope after 100 years?
   (1) Ca-37
   (2) U-238
   (3) P-32
   (4) Rn-222

24. The decay of which isotope can be used to estimate the age of the fossilized remains of an insect?
   (1) Rn-222
   (2) I-131
   (3) Co-60
   (4) C-14

25. Which radioisotope is used in medicine to treat thyroid disorders?
   (1) cobalt-60
   (2) iodine-131
   (3) phosphorus-32
   (4) uranium-238
A
nwers
To
Diagno
tic
Test
1
1. 4  2. 1  3. 1
4. 2  5. 4  6. 3
7. 3  8. 3  9. 1
10. 3  11. 2  12. 1
13. 1  14. 2  15. 2
16. 2  17. 4  18. 3
19. 2  20. 2
21. Carbon-13 has one more neutron than C-12.
22. melting
23. There are 15 neutrons.

A
nswers
To
Diagno
tic
Test
2
1. 2  2. 2  3. 1
4. 1  5. 1  6. 3
7. 2  8. 3  9. 4
10. 4  11. 4  12. 4
13. 2  14. 1  15. 4
16. 2  17. 4  18. 3
19. 2  20. 2  21. 3
22. 3  23. 3  24. 1
25. C₆H₁₂O₆ → 2CH₃OH + 2CO₂

A
nswers
To
Diagno
tic
Test
3
1. 3  2. 4  3. 4
4. 4  5. 2  6. 2
7. 3  8. 1  9. 4
10. 2  11. 4  12. 4
13. 4  14. 1  15. 3
16. 4  17. 4  18. 1
19. 3  20. 4  21. 2
22. 2  23. 1  24. 4
25. 4  26. C₃H₆  27. 40%
28. 2 moles  29. 0.50 mole  30. 81 g
31. C₆H₈O₆

A
nswers
To
Diagno
tic
Test
4
1. 1  2. 2  3. 1
4. 4  5. 2  6. 1
7. 1  8. 2  9. 3
10. 3  11. 1  12. 3
13. 3  14. 4  15. 1
16. 1  17. 3  18. 4
19. 1  20. 1  21. 3
22. 3

A
nswers
To
Diagno
tic
Test
5
1. 1  2. 3  3. 3
4. 1  5. 3  6. 3
7. 3  8. 1  9. 1
10. 4  11. 3  12. 3
13. 3  14. 4  15. 1
16. 4  17. 2  18. 1
19. 1  20. 4  21. 3
22. 3  23. 1  24. 2
25. 4  26. 4

A
nswers
To
Diagno
tic
Test
6
1. 1  2. 4  3. 3
4. 4  5. 4  6. 3
7. 4  8. 4  9. 2
10. 1  11. 1  12. 2
13. 4  14. 2  15. 2
16. 2  17. 3  18. 2
19. 4  20. 4  21. 3
22. 3

A
nswers
To
Diagno
tic
Test
7
1. 2  2. 3  3. 2
4. 1  5. 2  6. 1
7. 4  8. 1  9. 3
10. 3  11. 2  12. 3
13. 3  14. 3  15. 2
16. 4  17. 1  18. 2
19. 4  20. 1  21. 3
22. 4  23. 3  24. 2

A
nswers
To
Diagno
tic
Test
8
1. 1  2. 2  3. 4
4. 2  5. 3  6. 4
7. 3  8. 1  9. 4
10. 3  11. 2  12. 3
13. 3  14. 1  15. 2
16. 1  17. 3  18. 1
### Answers To Diagnostic Test 9

1. 1   2. 2   3. 2  
4. 2   5. 2   6. 4  
7. 3   8. 4   9. 1  
10. 3  11. 1  12. 2  
13. 1  14. 3  15. 2  
16. 2  17. 1  18. 2  
19. 4  20. 2  21. 4  
22. 1  23. 3  24. 3  

### Answers To Diagnostic Test 10

1. 3   2. 1   3. 4  
4. 3   5. 3   6. 3  
7. 2   8. 3   9. 3  
10. 1  11. 4  12. 2  
13. 4  14. 4  15. 2  
16. 4  17. 2  18. 3  
19. 2  20. 4  21. 4  
22. 1  23. 1  24. 1  
25. 4  26. 3  27. 4  
28. 2  29. 1  30. 3  

### Answers To Diagnostic Test 11

1. 3   2. 1   3. 2  
4. 1   5. 4   6. 4  
7. 2   8. 3   9. 4  
10. 2  11. 4  12. 1  
13. 2  14. 2  15. 4  
16. 4  17. 2  18. 3  
19. 3  20. 3  21. 1  
22. 2  23. 2  24. 3  
25. 4  26. 1  

### Answers To Diagnostic Test 12

1. 3   2. 2   3. 3  
4. 1   5. 3   6. 4  
7. 1   8. 4   9. 3  
10. 4  11. 4  12. 3  
13. 1  14. 1  15. 3  
16. 1  17. 3  18. 3  
19. 1  20. 1  21. 2  
22. 1  23. 1  24. 4  
25. 2
Review Questions

1. 1  2. 3  3. 2
2. 4  5. 2  6. 2
3. 7  8. 3  9. 3
4. The plum pudding model pictures the atom with an even distribution of positive charges, with electrons throughout the atom. The planetary model pictures the nucleus at the center of the atom with electrons in orbits.
5. Rutherford fired positively charged alpha particles at gold foil. He expected them to pass through with little deflection. When some were greatly deflected, he reasoned that they must have been repelled by a massive positively charged particle, which was called the nucleus.
6. The plum pudding model pictures the electrons in fixed, orbiting positions. The wave-mechanical model pictures electrons as possessing both wave and particle properties.
7. Na 1s²2s²2p⁶3s¹  
   Mg 1s²2s²2p⁶3s²  
   Al 1s²2s²2p⁶3s³3p¹  
   Si 1s²2s²2p⁶3s³3p²  
   P 1s²2s²2p⁶3s³3p³  
   S 1s²2s²2p⁶3s³3p⁴  
   Cl 1s²2s²2p⁶3s³3p⁵  
   Ar 1s²2s²2p⁶3s³3p⁶
8. 58. 1  59. 4  60. 1
   61. 1  62. 2  63. 4
   64. 4  65. 2  66. 2
   67. 2  68. 2  69. 1
9. The mixture contains at least three parts. One solid remained on the filter paper. The other two parts consist of a liquid with a solid dissolved in it.
10. If the calcium and sulfur can be separated by physical means, the substance is a mixture. If chemical means are required to separate them, it is a compound.
11. The picture should show several of each type of molecule evenly mixed.
12. A mixture of iron and oxygen would have the iron present as a solid and the oxygen present as a gas. The iron would be attracted to a magnet. A glowing splint would ignite into a flame if placed into the oxygen gas. If the iron and oxygen were combined as a compound, it would be a solid that is not attracted to a magnet.
13. Pepperoni pizza is heterogeneous because individual parts can be seen.
14. A is a mixture of an element and a compound; one molecule contains identical atoms and the other one contains different types of atoms. B is a compound; all particles are identical and are made up of two different types of atoms. C is an element; all molecules are identical and each is made up of two identical atoms. D is a mixture of an element and two different compounds; one molecule contains identical atoms and the other two contain different types of atoms, but they differ from each other.
15. Container D is homogeneous because the particles are mixed on the molecular level.
16. The two substances are different materials because their composition varies.

Regents Practice Questions

Part A
1. 1  2. 1  3. 1
4. 3  5. 1  6. 1
7. 2  8. 3  9. 1
10. 2  11. 3  12. 1
13. 2  14. 3

Part B
15. 4  16. 3  17. 1
18. 3  19. 1  20. 3
21. 1  22. 3  23. 2
24. 4

Part C
25. Because the two nuclei have different numbers of protons, they have different amounts of attraction for electrons. As a result, the amounts of energy separating the energy levels differ for the two elements.
26. The samples are not the same substance because the percent of each element differs from sample to sample.
27. Because he assumed the atom to have an even distribution of positive charges, he did not expect a concentration of positive charges that would strongly deflect or bounce back the alpha particles.
28. The spectra are based on the elements present in the compound. If some lines matched and some didn’t, the compounds have a least one element in common and at least one differing element.
29. Column 1: 1, 2, 1; column 2: K, 39, 19; column 3: 92, 146, 92
30. (0.9778)(12) + (0.0222)(13) = 12.02
31. They contain different numbers of neutrons.
32. (19.99 × .909) + (20.99 × 0.39) + (21.99 × 0.88)
33. 20
34. (12.00 × 9.93) + (13.00 × 1.07)
35. Both isotopes contain 6 protons but different numbers of neutrons. Or: An isotope with a mass of 12.00 contains 6 protons and 6 neutrons, while the isotope with a mass of 13.00 contains 6 protons and 7 neutrons.
**Review Questions**

1. 2 3
2. 4 3
4. 5 1 6
7. 8 4 9
10. 2 11. 3

12. Qualitative information: the compound is made of calcium, phosphorus and oxygen; phosphorus
and oxygen are combined to form the polyatomic phosphate ion. Quantitative information: one unit
of the compound contains three calcium atoms and two phosphate ions. Each phosphate ion
contains one phosphorus atom and four oxygen atoms.

13. (a) 3 potassium, 1 phosphorus, 4 oxygen
(b) 1 aluminum, 3 oxygen, 3 hydrogen
(c) 2 iron, 3 sulfur, 12 oxygen

14. (a) 6 potassium, 2 phosphorus, 8 oxygen
(b) 3 aluminum, 9 oxygen, 9 hydrogen
(c) 10 iron, 15 sulfur, 60 oxygen

15. (a) PO₄³⁻, phosphate (b) OH, hydroxide
(c) SO₄²⁻, sulfate

16. 2 17. 3 18. 3
19. 4 20. 4 21. 4

22. a) LiF b) CaO c) AlN d) BeCl₂
e) KI f) Al₂O₃

23. a) CO b) Br₂ c) SF₆ d) CO₂
e) CBr₄ f) NO₂

24. a) NaOH b) KNO₃ c) MgSO₄ d) AlPO₄
e) NH₄NO₃

25. a) sodium bromide
   b) magnesium sulfide
c) calcium oxide
d) magnesium chloride
e) aluminum fluoride
f) calcium iodide

26. a) dioxygen difluoride
   b) silicon tetrafluoride
c) tetrasulfur tetranitride
d) sulfur difluoride
e) dihydrogen sulfide
f) tetraphosphorus decaoxyde

27. a) calcium nitrate
   b) potassium hydroxide
c) magnesium carbonate
d) sodium phosphate
e) lithium nitrate
f) magnesium acetate

28. a) FeO b) SnS c) CuCl d) HgI₂ e) Pb(NO₃)₂
f) Fe₂O₃

29. a) copper (I) chloride
   b) iron (II) sulfide
c) mercury (II) iodide
d) lead(II) nitrate
e) tin (II) hydroxide
f) iron (III) oxide

30. 2

31. Sulfur is first because it has a lower electronegativity value

32. Roman numerals are used to show the charge or oxidation number of a metal that has more
   than one common oxidation number; chlorine is a nonmetal. The correct name is potassium chlorate.

33. V₂O₃ and V₂O₅

34. MgOH₄ does not show that there are two hydroxide ions. It states that there is only one oxygen atom
   and there should be two.

35. 1 36. 1 37. 2
38. 1 39. 2 40. 2
41. 1 42. 4 43. 2

39. H₂ + Br₂ → 2HBr
40. 3F₂ + 2Ar → 2ArF₃
41. S + O₂ → SO₂
42. Ca + Cl₂ → CaCl₂
43. 2Ni + O₂ → 2NiO
44. 2H₂O → 2H₂ + O₂
45. 2Al₂O₃ → 4Al + 3O₂
46. 2NaCl → 2Na + Cl₂
47. 2NH₃ → N₂ + 3H₂
48. 2H₂O → 2H₂ + O₂
49. a) FeO b) Mg(OH)₂ c) 2N₂ d) 2NH₃
50. a) 2NO (b) H₂O (c) 4NO (d) 2HCl
51. a) 6HCl (b) CO₂ (c) Cl₂ (d) Al₂O₃
52. a) S (b) H₂S (c) 2H₂O (d) CO₂
53. a) 2NO (b) H₂S (c) 2H₂O (d) CO₂
54. yes 55. yes 56. yes
57. no 58. yes

59. NaBr + AgNO₃ → NaNO₃ + AgBr
60. K₂CO₃ + Ca(NO₃)₂ → 2KNO₃ + CaCO₃
61. (NH₄)₂SO₄ + BaCl₂ → 2NH₄Cl + BaSO₄
62. Ba(NO₃)₂ + K₂CrO₄ → BaCrO₄ + 2KNO₃
63. 2NaOH + CaCl₂ → 2NaCl + Ca(OH)₂

64. (a) SR (b) D (c) S (d) DR (e) S (f) SR (g) DR (h) SR
   (i) D (j) D (k) DR (l) S (m) D (n) S (o) DR (p) SR
   (q) S (r) SR (s) DR (t) D

65. (a) CO₂ (b) 2KCl (c) 15O₂ (d) CO₃
66. (a) 6HCl (b) CO₂ (c) Cl₂ (d) Al₂O₃
67. (a) Mg(OH)₂ (b) 2N₂ (c) 2H₂O (d) 2NH₃
68. (a) 2NO (b) H₂O (c) 4NO (d) 2HCl
69. (a) Na₂S (b) 2Na₂Cr₂O₇ (c) 2HCl (d) K₂O

70. 144 g + 384 g = 528 g
71. 16.0 g + 71.0 g – 50.5 g = 36.5 g
72. 90 g + 68 g = 158 g
73. 595.8 g + 340.0 g – 156.2 g = 779.6 g
74. 47.8 g – 44.6 g = 3.2 g
75. 10.8 g + 95.8 g – 68.5 g = 38.1 g
76. 28.9 g – 8.0 g = 20.9 g
77. 10.8 metric tons + 1.8 metric tons = 12.6 metric tons
78. 318.2 lbs – 254.0 lbs = 64.2 lbs
79. 12.7 g + 3.2 g = 15.9 g

**Regents Practice Questions**

**Part A**

1. 4 2. 2 3. 2
4. 3 5. 3 6. 3
7. 3 8. 4 9. 2
11. 2

**Part B**

11. 4 12. 3 13. 4
14. 4 15. 1 16. 2
17. 2 18. 2 19. 2
20. 4 21. 4
Part C
22. FeCl₃, Fe(NO₃)₃; Roman numerals show the charge of metals that have more than one possible charge.
23. Polyatomic ions are groups of two or more atoms bonded together. They do not have an equal number of protons and electrons.
24. 2 aluminum, 3 sulfur, 12 oxygen
25. 153 – 117 = 36 grams of water
26. Any metal above hydrogen on the table will react, and any element below aluminum will not react.
27. NO₃⁻
28. Some wax melted.
29. There was a flame indicating that oxidation (burning) was taking place.
30. The coefficients are 1, 2, and 2.
31. Decomposition
32. The coefficients are 4, 3, and 2.
33. Synthesis
34. Mg(s) + 2HCl(aq) → MgCl₂(aq) + H₂(g)
35. single replacement
36. 4Fe(s) + 3O₂(g) → 2Fe₂O₃
37. synthesis

Answers To Topic 3

Review Questions
1. 4  4  4  4
2. 4  4  4  4
3. 3  5  3  6  4
4. 3  8  4  9  4
10. (a) 84.0 amu, 84.0 g (b) 95.3 amu, 95.3 g (c) 53.5 amu, 53.5 g (d) 162.4 amu, 162.4 g (e) 102.0 amu, 102.0 g (f) 148.3 amu, 148.3 g (g) 342.3 amu, 342.3 g (h) 132.1 amu, 132.1 g (i) 104.0 amu, 104.0 g (j) 342.0 amu, 342.0 g
11. 78.0 amu 12. 180.0 amu 13. 292.1 amu
14. 3  15. 2  16. 3
17. 2  18. 2  19. 2
20. 3  21. 1  22. 3
23. 2
24. The crystals were a hydrate. Heating removed the water of hydration.
25. (a) Hydrated copper (II) sulfate is blue; anhydrous copper (II) sulfate is white. (b) Add water.
26. The anhydrous form is 100% Na₂B₄O₇. The hydrated crystal is almost 50% water, so it is almost twice as expensive.
27. 3  28. 4  29. 2
30. 3  31. 3  32. 1
33. 4  34. 4  35. 4
36. 3  37. 1  38. 4
39. 4  40. C₅H₄  41. C₆H₅
42. C₆H₅O₆  43. C₆H₅
44. No, the gram formula mass must be a multiple of the empirical mass which is 30.
45. 2  46. 3  47. 4
48. 1  49. 4  50. 3
51. 1  52. 3  53. 4
54. 3  55. 3  56. 50
57. mole and molecule ratios

58. She changed the formula of NH₃ to NH₄. You cannot change formulas to balance equations. N₂ + 3H₂ → 2NH₃
59. Coefficients represent mole and molecule ratios, not gram ratios.
60. 24 mol CO₂; 24 mol H₂O
61. 36
62. 6 mol
63. 4 mol
64. 2 mol of chlorine will not be used.
65. The first drawing should show six diatomic hydrogen molecules and two diatomic nitrogen molecules. The second drawing should show two ammonia molecules, each of which contains one nitrogen atom with three hydrogen atoms attached to it.

Regents Practice Questions

Part A
1. 3  2. 3  3. 3
4. 1  5. 2  6. 3

Part B
7. 3  8. 4  9. 4
10. 4  11. 4  12. 2
13. 4  14. 2  15. 1
16. 172 g  17. 180 amu  18. 62 g
19. 29.2%  20. 69.5%  21. 27.5%
22. 12.5%
23. Molecular formula contains the numbers of atoms in a molecule, while the empirical shows the lowest integer ratio of the atoms.
24. C₆H₆O₆  25. 52 g  26. 4 mol
27. 6 mol  28. 12 mol
29. Mg + 2HCl → MgCl₂ + H₂
30. 0.10 mol  31. 0.10 mol  32. 7.0 mol
33. 20 mol

Answers To Topic 4

Review Questions
1. 4  2. 1  3. 1
4. 2  5. 2  6. 3
7. 3  8. 2  9. 1
10. 2  11. 2  12. 3
13. 4  14. 1  15. 4
16. 2  17. 2  18. 4
19. 1  20. 2  21. 4
22. 3  23. 4  24. 1
25. 1  26. 3  27. 1
28. 3  29. 3  30. 4
31. 2  32. 3  33. 1
34. 3  35. 2  36. 2
37. 4  38. 6.00 g  39. 4080 J
40. 31.2°C  41. 45.2°C  42. 1.2°C
43. 50.1 kJ  44. 226 kJ  45. 2.26 × 10⁴ J
46. 1380 J/g  47. 1  48. 3
49. 1  50. 4  51. 1
52. 3  53. 3  54. 1
55. 2  56. 2  57. 3  58. 3  59. 4  60. 4  61. 3  62. 2  63. 3  64. 5 L  65. 100 mL  66. 225 mL  67. 3  68. 2  69. 1

Regents Practice Questions

Part A

1. 4  2. 2  3. 2  4. 3  5. 1  6. 2  7. 2  8. 4  9. 4  10. 2  11. 2  12. 3  13. 1  14. 2  15. 4  16. 3100 joules  17. 1  18. 138  19. $9.04 \times 10^2$ J  20. $9.0 \times 10^2$ J  21. 0.5 mol CO$_2$

22. They are at the same conditions of temperature, pressure and volume.

23. 1.5 atm  24. 2.0 atm  25. 106 kilopascals  26. 50°C  27. 30°C is either the melting or boiling point of the substance.


Example of a 1-credit response:

![Graph](image)

29. [1] Allow 1 credit for all five points plotted correctly ± 0.3 grid space. Plotted points do not need to be circled or connected.

Examples of 2-credit responses to questions 51 and 52:

![Graph](image)

30. 3.0 atm

Review Questions

1. 1  2. 2  3. 2  4. 4  5. 2  6. 2  7. 4  8. 2  9. 3  10. 1  11. 1  12. 4  13. 3  14. 3  15. 1  16. 4  17. 3  18. 3  19. 1  20. 4  21. 3  22. 1  23. 3  24. 3  25. 3  26. 3  27. 2  28. 4  29. 2  30. 4  31. 1  32. 3  33. 4  34. 1  35. 4  36. 4  37. 1  38. 2  39. 1  40. 4  41. 3  42. 1  43. 4  44. 2  45. 1  46. 2  47. 1  48. 4  49. 1  50. 1  51. 2  52. 4  53. 4  54. 3  55. 2  56. 2  57. 3  58. 3  59. 2  60. 1  61. 3  62. 3  63. 1  64. 1  65. 3  66. 1  67. 2  68. 2  69. 4  70. 1  71. 1  72. 3  73. 1  74. 2

75. The second electron lost from magnesium is the only electron in the valence level. A second electron lost from sodium must come from a stable, complete valence level.

76. Both the sodium ion and neon have ten electrons, but the sodium ion has an additional proton to attract the electrons.

77. I$_2$ + H$_2$O $\rightarrow$ HIO + H$^+$ + I$^-$

78. The vertical columns of the table should have elements with similar chemical properties. If the elements were arranged by atomic mass, several pairs of elements, such as Ar and K, would be out of position in regards to properties.

79. Both groups follow the octet rule. Group 1 members achieve an octet by losing an electron, and Group 17 elements each gain an electron to have an octet of electrons.

80. MBr$_3$, M$_2$O$_3$; a member of Group 13 has three valence electrons and will form a 3+ ion.

81. Although all elements in Group 1 have one valence electron, hydrogen does not have the characteristics of the other members of Group 1. It has unique properties and is considered a group of its own.

82. Across a period, radius decreases, so boron should be larger than carbon. Down a group, the radius increases, so aluminum should be the largest. Across a period, ionization energy generally increases, so carbon has greater ionization energy than boron. Down a group, ionization energy decreases, so aluminum is least.

83. They have the same number of valence electrons.
84. The left side of the periodic table is composed of metals, which have few valence electrons. Moving to the right, there are more electrons and their mobility is less, reducing their metallic properties. When most of the orbitals are filled, the atoms take on nonmetallic characteristics. When orbitals are full, a noble gas configuration is attained.

85. Metals become positive ions.

86. When sodium loses one electron, it has an octet of electrons and becomes quite stable. The loss of an additional electron would reduce its stability.

87. MCl₂
88. MgX₂
89. M₂O
90. argon and potassium, tellurium and iodine

Regents Practice Questions

Part A
1. 1  2. 4  3. 2
4. 4  5. 1  6. 4
7. 2  8. 1  9. 2
10. 4  11. 4  12. 2
13. 2  14. 2

Part B
15. 4  16. 1  17. 4
18. 1  19. 3  20. 3
21. 4  22. 2  23. 1
24. 3  25. 4  26. 4
27. 3  28. 2  29. 3

Part C
30. He placed the tellurium and iodine into the columns of elements with similar chemical properties.

31. Mg²⁺ and Al³⁺ are isoelectronic and have the electron configuration of Ne. S²⁻, Cl⁻, and K are also isoelectronic and have the electron configuration of Ar. Ba²⁺ has the electron configuration of Xe.

32. 13
33. Ge and As
34. Group 1 metals all become ions with a 1+ charge.
35. Solid
36. The valence electrons of Group 2 are mobile.
37. The radius of positive ions is smaller than the atomic radii because one or more electrons have been lost.
38. MI₂
39. +113
40. Any member of Group 13, but especially Tl
41. Radium and calcium each have two valence electrons.
42. Group 1 contains metals which lose electrons, while Group 17 members are nonmetals and gain electrons.
43. Na⁺ has a higher ionization energy as it has 11 protons holding 10 electrons while Na has 11 protons holding 11 electrons.

Answers to Topic 6

Review Questions
1. 2  2. 1  3. 2
37. Diagrams of the molecules should be like the ammonia molecule in Figure 6–10 on page 85. Dotted lines should connect the nitrogen atom of one molecule to the hydrogen atoms of another molecule.

38. H - C : C - H  
H : C - C : H  
H : C : C : H

**Answers To Topic 7**

**Review Questions**

1. 4  
2. 2  
3. 3  
4. 4  
5. 4  
6. 3  
7. 2  
8. 1  
9. 1  
10. 1  
11. 2  
12. 3  
13. 2  
14. 4  
15. 3  
16. 1  
17. 1  
18. 3  
19. 4  
20. 3  
21. 2  
22. 1  
23. 2  
24. 2  
25. 3  
26. 3  
27. 1  
28. 2  
29. 4  
30. 3  
31. 3  
32. 4  
33. 2  
34. 7.3%  
35. 170 g, 137 g  
36. 3.4 ppm  
37. It becomes less soluble as temperature increases.  
38. 1  
39. 3  
40. 4  
41. 2  
42. 4  
43. 1  
44. 4  
45. 2  
46. 4  
47. 3  
48. 1  
49. 4  
50. 2

**Regents Practice Questions**

**Part A**

1. 2  
2. 1  
3. 2  
4. 2  
5. 2  
6. 3  
7. 1  
8. 2  
9. 3  
10. 2  
11. 1  
12. 1

**Part B**

13. 2  
14. 4  
15. 3  
16. 3  
17. 3  
18. 3  
19. 2  
20. 3  
21. 3  
22. 1  
23. 1  
24. 1  
25. 3  
26. 11.1%  
27. 67 mL  
28. Mass of solute  
29. 1.4 M  
30. 51 g

**Part C**

31. Decrease the pressure, or increase the temperature.  
32. At first the solubility rises, then it decreases as temperature increases. The solubility of most solids consistently increases with increasing temperature.  
33. Solution A, it has the greatest concentration of ions.  
34. 500. mL of 4.0M NaOH contains 2 mol NaOH, which is 80. g NaOH. Place 80. g NaOH in a graduated container. Add enough distilled water to dissolve the NaOH by swirling or stirring. When the solute is dissolved, add enough distilled water to make 500. mL of solution.

35. Decrease the temperature to 35°C, or add 25 g more solute.  
36. Of the two points on the line, point F must represent the point of saturation because the solution became saturated and the temperature increased from the exothermic solution process.  
37. As the temperature increases, the solubility of SO₂ decreases.  
38. 45°C  
39. Decrease the pressure or increase the temperature  
40. None, pressure does not affect the solubility of solids in liquids.

**Answers To Topic 8**

**Review Questions**

1. 2  
2. 1  
3. 2  
4. 2  
5. 4  
6. 4  
7. 3  
8. 1  
9. 3  
10. 2  
11. 4  
12. 2  
13. 1  
14. 2  
15. 2  
16. 1  
17. 3  
18. 2  
19. 2  
20. 4  
21. 2  
22. 3  
23. 4  
24. 3  
25. 4  
26. 1  
27. 3  
28. 1  
29. 1  
30. 3  
31. 1  
32. 1  
33. 2  
34. 4  
35. 2  
36. 2  
37. 2  
38. 2  
39. 3

**Regents Practice Questions**

**Part A**

1. 1  
2. 2  
3. 3  
4. 2  
5. 4  
6. 4  
7. 3  
8. 2  
9. 3  
10. 1  
11. 2  
12. 4  
13. 3  
14. 2  
15. 2  
16. 3  
17. 3

**Part B**

18. 1  
19. 1  
20. 4  
21. 2  
22. 1  
23. 4  
24. 4  
25. 3  
26. 2  
27. 3  
28. 1  
29. 1  
30. 4  
31. 2  
32. 3  
33. 3  
34. 4

**Part C**

35. The system will shift to the left, or any of the following: Nitrate ion concentration will increase, or potassium ion concentration will decrease or the amount of potassium nitrate solid will increase.  
36. The rate of dissolving and recrystallization are equal.  
37. The solubility of CO₂ (g) decreases. Do not accept, “Soda goes flat”.  
38. The solubility of CO₂ (g) decreases. Do not accept, “Soda goes flat”.  
39. A catalyst lowers the activation energy.
40. **a.** In the space provided in your answer booklet, show a correct numerical setup for calculating the percent composition by mass of water in this compound. [1]

**b.** Record your answer. [1]

---

f. The reaction is endothermic because the potential energy of the reactants is less than the potential energy of the products.

---

41. The system shifts to the right. It responds to the decrease of CO₂ by decomposing the H₂CO₃ to shift to the right and replace the lost CO₂.

42. The system shifts to the left to reduce the stress of added energy.

43. More collisions between reactants results in a shift to the product (right) side.

44. As the particles move faster they collide more often and more effectively.

---

45. Decrease heat, increase pressure, and increase concentration of N₂ and H₂.
37. (a) hydrofluoric acid (b) hydroselenic acid (c) hydriodic acid
38. (a) Ca + 2HCl → CaCl₂ + H₂ (b) Zn + 2HNO₃ → Zn(NO₃)₂ + H₂ (c) Pb + H₂CO₃ → PbCO₃ + H₂ (d) 2Al + 6CH₃COOH → 2Al(CH₃COO)₃ + 3H₂ (e) no reaction
39. (a) NaOH + HNO₃ → H₂O + NaNO₃, sodium nitrate (b) Mg(OH)₂ + HNO₃ → Mg(NO₃)₂ + H₂O, magnesium nitrate (c) Mg(OH)₂ + H₂SO₄ → MgSO₄ + 2H₂O, magnesium sulfate (d) 2KOH + H₂SO₄ → 2K₂SO₄ + H₂O, potassium sulfate (e) 3LiOH + H₃PO₄ → Li₃PO₄ + 3H₂O, lithium phosphate (f) 3Ca(OH)₂ + 2H₃PO₄ → Ca₃(PO₄)₂ + 3H₂O, calcium phosphate
40. 4
41. 4
42. 2
43. 4
44. 4
45. 2
46. 25 mL
47. 3000 mL
48. 20 mL
49. 5 mL
50. 6.0 M
51. 0.60 M
52. 400 mL
53. 1.0 M
54. 2.7 M
55. H⁺Cl⁻
56. \[\text{H} : \text{O} : \text{H}^-\]
57. \[\text{O} : \text{H}^-\]
58. hydroxide ion + hydrogen ion (hydronium ion) → water
59. \[\text{H} : \text{O} : \text{H}^-\] + \[\text{O} : \text{H}^-\] → 2H₂O
60. sodium phosphate
61. 4
62. 1
63. 3
64. 3
65. 3
66. 2
67. 1
68. 1
69. 4
70. 2
71. Bromcresol green
72. Between 5.4 and 6.0
73. (a) blue (b) yellow
74. b
75. 1

Regents Practice Questions

Part A
1. 1
2. 3
3. 2
4. 4
5. 2
6. 3
7. 1
8. 2
9. 1
10. 4
11. 2

Part B
12. 4
13. 3
14. 4
15. 3
16. 1
17. 1
18. 1
19. 4
20. 2
21. 1
22. 3
23. 1
24. 2
25. 4
26. A, C, & D
27. D
28. Presence of hydrogen ions
29. C
30. A
31. 0.02
32. 7
33. Colorless to pink
34. 0.21 M
35. 0.97 M
36. Reduces the effects of random error, increases reliability

Chemistry Answer Key
The OH from one amino acid and an H from the other amino acid will be removed to form water. The resulting structures will join in a peptide linkage.

64. fat + alkali $\rightarrow$ glycerol soap

65. In a substitution reaction, an atom is removed from an existing molecule and replaced with another atom. In an addition reaction, a double or triple bond is broken and atoms are added at the site.

66. 4  67. 2  68. 1
69. 3  70. 5

**Regents Practice Questions**

**Part A**

1. 4  
2. 1  
3. 3
4. 4  
5. 1  
6. 4
7. 1  
8. 3  
9. 2
10. 4  
11. 4  
12. 3
13. 2  
14. 3  
15. 2

**Part B**

16. 1  
17. 4  
18. 1
19. 1  
20. 1  
21. 1
22. 2  
23. 3  
24. 2
25. 2  
26. 2  
27. 3
28. 2  
29. 3  
30. 3

31. [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to:

32. 2-chlorobutane
33. Esters
34. Alkenes, or $C_nH_{2n}$
35. Addition

36. [1] Allow 1 credit for a correct response. Acceptable responses include, but are not limited to:


Examples of a 1-credit response:

38. Substitution, or halogenations


Examples of a 1-credit response:
40. [1] Allow 1 credit.

Examples of a 1-credit response:

\[ \text{H H H O H} \]
\[ \text{H C C C O C H} \]
\[ \text{H H H H} \]
\[ \text{O} \]
\[ \text{C O C H}_2 \text{CH}_2 \text{CH}_3 \]

41. Butanol or n-butanol

42. [1] Allow 1 credit.

Examples of a 1-credit response:

\[ \text{H C H H} \]
\[ \text{H H H H} \]
\[ \text{H C C C C C H} \]
\[ \text{H H H H} \]
\[ \text{O} \]
\[ \text{C C H C C C H} \]

43. [1] Allow 1 credit.

Examples of a 1-credit response:

\[ \text{H C C C O} \]
\[ \text{H C C C H} \]
\[ \text{H C C C C C} \]

44. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- ethanoic acid
- acetic acid

45. [1] Allow 1 credit.

Examples of a 1-credit response:

\[ \text{H H H C C C C} \]
\[ \text{H H C C O} \]
\[ \text{H O C C C H} \]

Answers To Topic 12

Review Questions

1. 1  2. 2  3. 1
4. 4  5. 1  6. 4
7. 1  8. 1  9. 3
10. 1  11. 3  12. 3
13. 2  14. 3
15. (a) \(^{210}\text{Pb} \rightarrow \text{He} + \text{Bi}\)
(b) \(^{137}\text{Cs} \rightarrow \text{He} + \text{Ba}\)
(c) \(^{222}\text{Rn} \rightarrow \text{He} + \text{Po}\)
(d) \(^{197}\text{Au} \rightarrow \text{He} + \text{Hr}\)
(e) \(^{54}\text{Fe} \rightarrow \text{He} + \text{Mn}\)
(f) \(^{20}\text{Ca} \rightarrow \text{He} + \text{K}\)
16. 4  17. 1  18. 2
19. 2  20. 1  21. 2
22. 1  23. 1  24. 3
25. 2  26. 4  27. 2
28. 3  29. 1  30. 2
31. 2  32. 1  33. 1
34. 3  35. 1  36. 2
37. 3  38. 4  39. 2
40. 4  41. 3  42. 2
43. 4  44. 1  45. 3
46. 3  47. 4  48. 4
49. 4  50. 3  51. 1
52. 4  53. 4  54. 4
55. 1  56. 2  57. 3

Regents Practice Questions

Part A

1. 2  2. 4  3. 2
4. 3  5. 4  6. 3
7. 3  8. 3  9. 3
10. 4

Part B

11. 2  12. 4  13. 2
14. 1  15. 2  16. 2
17. 1  18. 2  19. 2
20. 2  21. 2
22. \(^{24}\text{Al} \rightarrow \text{He} + \text{Mg}\)
23. $^{32}\text{Si} \rightarrow 0^+ + ^{31}\text{P}$
24. $^{226}\text{Ra} \rightarrow ^{226}\text{He} + ^{226}\text{Rn}$
25. 2.5 g
26. $^{160}\text{Sm}$

Part C
27. $^{214}\text{Po} \rightarrow ^{4}\text{He} + ^{210}\text{Pb}$, $^{210}\text{Pb} \rightarrow 0^+ + ^{206}\text{Bi}$
28. (a) unstable (b) stable (c) unstable
29. An alpha particle is positively charged and is repelled by the nucleus, but the neutron is neutral and does not have to overcome electrostatic repulsions.
30. 

```
Time (min) | Counts (per min)
-----------|------------------
0          | 12,000
1          | 11,000
2          | 10,000
3          | 9,000
4          | 8,000
5          | 7,000
6          | 6,000
7          | 5,000
8          | 4,000
9          | 3,000
10         | 2,000
11         | 1,000
12         | 0

half-life = 2.5 min
```

31. $^{29}\text{X} \rightarrow 0^+ + ^{29}\text{X}^0$; $^{38}\text{Y} \rightarrow 0^+ + ^{38}\text{Y}^0$

The product of the alpha decay of X would be located one unit to the right of X. The product of the positron emission of Y would be located one unit to the left of Y.

32. If the amount were less than assumed, the ratio of C-12 to C-14 would be greater than expected, and the object would appear to be older than it really is.
33. $^{251}\text{Md}$
34. Less air pollution
   Low cost, conservation of fossil fuels, more energy produced
35. Nuclear meltdown, cancer, mutations, environmental, contamination
36. Bones become radioactive
   Sr-90 emits beta particles
   Sr-90 is radioactive
37. Fission
38. Matter has been converted into energy
39. Fusion
40. Alter DNA, change genetic information
41. $^{241}\text{Am} \rightarrow ^{237}\text{Np} + ^{4}\text{He}$
42. Kr-85 undergoes beta decay
   Am-241 undergoes alpha decay
   Or they have different half-lives
43. a positron or $0^+ e$
44. $^{133}\text{Cs} \rightarrow 0^+ e + ^{133}\text{Ba}$
45. One hundred grams
46. Beta decay
47. 28,650 years
48. Iodine-131 has a shorter half-life and decays faster.
49. $^{14}\text{C} \rightarrow 0^+ e + ^{14}\text{N}$
50. It decays too fast.
51. 17,900 years
52. $^{59}\text{Fe} \rightarrow 0^+ e + ^{59}\text{Co}$
53. 1/16
Strategies for Answering Test Questions

Answers for Questions Based on Readings

1. $^{85}\text{Cs}^{135} \rightarrow \gamma e^0 + ^{56}\text{Ba}^{137}$
2. 100 (one hundred)
3. Iodine-131 has a shorter half-life and decays faster.
4. The electron of hydrogen absorbs energy and jumps to a higher energy state. The excited electron falls back to a lower level and releases energy related to a particular color.
5. The spectra from a star is compared to spectra of known elements.
6. $5 \text{ error} = \frac{647 - 656 \times 100}{656}$
7. [1] Allow 1 credit. Molecules of the gas must be drawn farther apart than molecules of the liquid. 
   **Example of a 1-credit response:**

   **Example of a 1-credit response:**

9. [1] Allow 1 credit. Significant figures do not need to be shown. Acceptable responses include, but are not limited to:
   - $5550 \text{ kJ}$
   - $5.5 \times 10^3 \text{ kJ}$

    **Examples of 1-credit responses:**

    \[ 
    \begin{array}{c}
    \text{H} \\
    \text{H-C-S} \\
    \text{H} \\
    \end{array} 
    \]

Appendix 2 Answers

Graphing Practice Problems

1. (a) pressure is the independent variable; volume is the dependent variable
   (b) 

   **Pressure Versus Volume For a Confined Gas**

   \[ 
   \begin{array}{c}
   \text{Pressure (kPa)} \\
   \text{Volume (mL)} \\
   \end{array} 
   \]

   (c) inverse
   (d) approximately 187.5 kPa
   (e) approximately 17 to 18 mL
2. **Volume Versus Number of Books**

   - Number of books
   - Volume (mL)

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<tr>
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3. **Volume Versus Temperature For a Gas**

   - Temperature (°C)
   - Volume (cm³)

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<th>Volume (cm³)</th>
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</tbody>
</table>

   - (a)
   - (b) direct
   - (c) temperature is the independent variable; volume is the dependent variable
   - (d) approximately 208 cm³

4. **Atomic Radii Versus Atomic Number**

   The atomic radii of the period 2 and 3 elements vary periodically with increasing atomic number. In general, the atomic radii decrease as you move left to right across a period. Also, within a group, the radii of the period 3 elements are greater than the radii of the period 2 elements.

5. **Boiling Point Versus Atomic Number**

   There is a direct relationship between the atomic number and the boiling point. Student explanations will vary, but might mention that Van der Waals forces increase as the number of electrons in the atom increase.
6. [1] Allow 1 credit for marking an appropriate scale on the axis labeled “Temperature (°C).” An appropriate scale is one that allows a trend to be seen.

7. [1] Allow 1 credit for plotting six or seven points correctly (±0.3 grid space). Plotted points do not need to be circled or connected.

8. [1] Allow 1 credit for marking an appropriate scale. An appropriate scale is one that allows a trend to be seen.

9. [1] Allow 1 credit for plotting all the points correctly (±0.3 grid space). Plotted points do not need to be circled or connected.

10. [1] Allow 1 credit for marking an appropriate linear scale. An appropriate scale is one that allows a trend to be seen.

11. [1] Allow 1 credit for plotting all the points correctly (±0.3 grid space). Plotted points do not need to be circled or connected.

12. [1] Allow 1 credit for marking an appropriate linear scale. An appropriate scale is one that allows a trend to be seen.

13. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   As atomic number increases, first ionization energy decreases.

   Ionization energy decreases.

**Significant Figures**

14. 3  
15. 4  
16. 1  
17. 1  
18. 3  
19. 3  
20. 3  
21. 2  
22. 3  
23. 3  
24. 2  
25. 1  
26. 2  
27. (a) 5610.3 g  
    (b) 0.029 g  
28. (a) 2.70 g/cm³  
    (b) 10. g  
29. 3  
30. 3  
31. 3  
32. 3  
33. 2  
34. 3  

**Appendix 3 Answers**

1. 47.2 L  
2. 3  
3. 2  
4. 4  
5. 450 atm  
6. 4  
7. 2  
8. 4  
9. 1  
10. 4  
11. 3  
12. 2  
13. 1  
14. 1  
15. 2  
16. 2  
17. 1  
18. a) 90  
    b) 60  
19. 7 g  
20. 2  
21. 1  
22. 2  
23. 3  
24. 4  
25. 3  
26. 3  
27. 3  
28. 2  
29. 2  
30. 1  
31. 2  
32. 1  
33. 3  
34. 4  
35. 2  
36. 1  
37. 3  
38. 3  
39. colorless to pink  
40. yellow  
41. 2  
42. 1  
43. 3  
44. 4  
45. 1  
46. 1  
47. 4  
48. 2  
49. 4  
50. 4  
51. 1599 y  
52. 1  
53. 2  
54. 4  
55. 3  
56. 4  
57. 4  
58. 2  
59. 1  
60. 1  
61. 2  
62. 3  
63. 2  
64. 3  
65. 3  
66. 1  
67. 1  
68. 4  
69. 2  
70. 1  
71. 2  
72. 3  
73. 2  
74. 3  
75. 4  
76. 1  
77. 3  
78. 3  
79. 2  
80. 3  
81. 4  
82. 4  
83. 3  
84. 6.82 g/mL  
85. 3.62 g/mL  
86. 3  
87. 96 g  
88. 5.9%  
89. 15.8%  
90. 2  
91. 2  
92. 2  
93. 3  
94. 1  
95. 3  
96. 3  
97. 2  
98. 3  
99. 1  
100. 2  
101. 1  
102. 3  
103. 1.42 ppm  
104. 2  
105. 0.42 L  
106. 16.8 g  
107. 1.25 L  
108. 3  
109. 3  
110. 99.1 L  
111. 2  
112. 2  
113. 3  
114. 2  
115. 8359 J  
116. 2  
117. 4  
118. 3  
119. −21°C  
120. 1535°C  
121. 2  
122. 3  
123. 1  
124. 2  
125. 2  
126. 3  
127. 2  
128. 151 y
Part A

1. Si
   Silicon
   Element 14

2. As atomic number increases, the electronegativity increases.
   Electronegativity increases.
   From lower to higher

3. White phosphorus has fewer atoms per cm³. Red has more.
   Note: Do not allow credit for a response that only indicates the number of atoms per cm³ in red phosphorus.

4. Ga
   Indium
   Element 31
   Element 49

5. The entropy of KNO₃(s) is less than the entropy of KNO₃(aq).
   The KNO₃(aq) is more disordered.
   The solution is more random than the solid.
   Note: Do not allow credit for a response that only indicates the entropies are different.

Part B

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   Si
   Silicon
   Element 14

52. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   As atomic number increases, the electronegativity increases.
   Electronegativity increases.
   From lower to higher

53. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   White phosphorus has fewer atoms per cm³. Red has more.
   Note: Do not allow credit for a response that only indicates the number of atoms per cm³ in red phosphorus.

54. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   Ga
   Indium
   Element 31
   Element 49

55. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The entropy of KNO₃(s) is less than the entropy of KNO₃(aq).
   The KNO₃(aq) is more disordered.
   The solution is more random than the solid.
   Note: Do not allow credit for a response that only indicates the entropies are different.

56. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   Both samples are at 20.1°C, but the larger sample has more mass.
   The larger sample has twice as many particles.
   The total thermal energy is directly proportional to the masses of the samples.

57. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The boiling point of the NaNO₃ solution is higher than the boiling point of water.
   Lower for H₂O

58. [1] Allow 1 credit for 30 g/mol, 30.0 g/mol, or for any value from 30.06 g/mol to 30.1 g/mol, inclusive.

59. [1] Allow 1 credit for 4 or four.

60. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The catalyzed reaction pathway has a lower activation energy than the original reaction.
   Less energy is needed.

61. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   Hydrogen atoms are added to the ethene molecule at the site of the carbon-carbon double bond to form a single molecule.
   Two reactants combine to form a single product.
   Two substances form one.
   Two hydrogen atoms are added at C=C.
   An unsaturated reactant becomes a saturated product.
   The reaction is a hydrogenation reaction, which is a type of addition reaction.

62. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   \( (0.026 \text{ M})(50.0 \text{ mL}) = M_b(38.5 \text{ mL}) \)
   \( \frac{(0.026)(50)}{38.5} \)

63. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   KCl
   CI⁻
   K⁺(aq) + Cl⁻(aq)
   K⁺ + Cl⁻

64. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   –OH
   OH
   Alcohol
   Hydroxyl
   Hydroxy group
   Note: Do not allow credit for hydroxide ion or hydroxyl radical or OH⁻.

65. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The number of each kind of atom is the same in both, but their structures are not the same.
Their molecular formulas are the same, but their structural arrangement of atoms is different.

The only difference is the arrangement of the atoms.

**Part C**

Allow a total of 20 credits for this part. The student must answer all questions in this part.

66. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- sodium hydrogen carbonate
- sodium bicarbonate
- sodium acid carbonate
- monosodium carbonate
- bicarbonate of soda

67. [1] Allow 1 credit for 14% or for any value from 14.28% to 14.3%, inclusive.

68. [1] Allow 1 credit for blue.

69. [1] Allow 1 credit for any value from 61 g to 63 g, inclusive.

70. [1] Allow 1 credit for \(\underline{2} \text{NH}_4\text{Cl} + \underline{1} \text{CaO} \rightarrow \underline{2} \text{NH}_3 + \underline{1} \text{H}_2\text{O} + \underline{1} \text{CaCl}_2\).

   **Note:** Allow credit even if the coefficient “1” is written in front of CaO, H2O, and/or CaCl2.

71. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- There is a greater electronegativity difference in a C–O bond than in a C–H bond.
- The C–O bond is more polar because the electronegativity difference for a C–O bond is 0.8, and the electronegativity difference for a C–H bond is 0.4.
- The C–H bond has a smaller difference.
- The C–O is .8 and the C–H is .4.

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- hydrogen bonding
- dipole–dipole

73. [1] Allow 1 credit for any value from 48 kPa to 52 kPa, inclusive.

74. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- A 2-propanol molecule is polar because it has an asymmetrical distribution of charge.
- The charge distribution is uneven.
- The center of positive charge and the center of negative charge do not coincide.

75. [1] Allow 1 credit.

**Examples of 1-credit responses:**

- \(\text{H} \quad \text{OH} \quad \text{H}\)
- \(\underline{2} \text{C} = \underline{2} \text{C} = \underline{2} \text{C} - \underline{2} \text{OH}

76. [1] Allow 1 credit. The position of electrons may vary.

**Examples of 1-credit responses:**

- \(\text{S} \quad \text{H} \quad \text{H}\)
- \(\text{S} - \quad \text{H} \quad \text{H}\)
- \(\text{H} : \text{S} : \text{H}\)

77. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- Ar
- argon
- element 18

78. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- The rate of the forward reaction is equal to the rate of the reverse reaction.
- They are the same.
- equal

79. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- 0 to \(-1\)
- 0 to \(-1\) zero to negative one
- 0 to minus one

80. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- The container must be closed so that no matter can enter or leave, thus disturbing the equilibrium.
- If the container is open, Cl2 gas escapes.
- to keep the concentrations of the reactants and products constant

81. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- The concentration of the ClO\(^-\) ion decreases.
- \([\text{ClO}^-]\) decreases.
- lower ClO\(^-\) concentration
- less ClO\(^-\)

82. [1] Allow 1 credit for 74.

83. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- I-127 atoms and I-131 atoms have the same number of protons, but different numbers of neutrons.
- Both have 53 p, but I-127 has 74 n while I-131 has 78 n.
- They have the same atomic number but different mass numbers.
- same atomic number but different numbers of neutrons
- The only difference is the number of neutrons.
84. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

\[ { }^{104}_{125} \text{Sb} \]
\[ { }^{104}_{51} \text{Sb} \]
\[ \text{Sb-104} \]
\[ \text{antimony-104} \]

85. [1] Allow 1 credit for 48 d, 48.0 d, 48.1 d, or for any value from 48.12 d to 48.13 d, inclusive.
The State Education Department / The University of the State of New York

Regents Examination in Physical Setting/Chemistry – January 2014
Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

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### Part A

|   | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26. | 27. | 28. | 29. | 30. |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|   | 3  | 4  | 3  | 6  | 2  | 8  | 3  | 9  | 4  | 11 | 4  | 12 | 4  | 14 | 2  | 15 | 2  | 17 | 3  | 18 | 4  | 20 | 2  | 21 | 4  | 23 | 1  | 24 | 1  | 25 | 2  | 30 | 3  |

### Part B–1

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### Part B–2

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51. [1] Allow 1 credit for \(3 \text{Mg(s)} + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s)\).

52. [1] Allow 1 credit for Ne or neon.

53. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - An atom of magnesium loses its outer shell electrons to form the Mg\(^{2+}\) ion.
   - The electron configuration of a magnesium atom is 2-8-2, and the electron configuration of the magnesium ion is 2-8.
   - An atom of the metal loses electrons to form the ion.

54. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - covalent
   - double covalent
   - nonpolar
   - double

55. [1] Allow 1 credit.

   **Examples of 1-credit responses:**

   ![Chemical structures](image)

56. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - Energy is needed to break the bonds in O\(_2\).

57. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - The potential energy remains the same, but the average kinetic energy of the H\(_2\)O molecules increases.
   - There is no change in potential energy. There is an increase in the average kinetic energy.

58. [1] Allow 1 credit for 8 kJ \(\pm\) 1 kJ.

59. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - The heat of vaporization of water is 2260 J/g and the heat of fusion for water is only 334 J/g.
   - The heat of fusion of water is much less than its heat of vaporization.

60. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - The number of gas molecules in cylinder A is the same as the number of gas molecules in cylinder B.

61. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - Temperature: above 293 K
   - Pressure: below 1.2 atm
   - Temperature: higher
   - Pressure: lower

62. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   \[
   \frac{(1.2 \text{ atm})(1.25 \text{ L})}{293 \text{ K}} = \frac{(1.0 \text{ atm})(V_2)}{273 \text{ K}}
   \]

63. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - alkanes
   - C\(_n\)H\(_{2n+2}\)

64. [1] Allow 1 credit for C\(_x\)H\(_y\), The order of the elements can vary.

65. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - Isomer 2 boils at a lower temperature because it has weaker intermolecular forces than isomer 1.
   - The intermolecular forces in isomer 1 are stronger.

### Part C

Allow a total of 20 credits for this part. The student must answer all questions in this part.

66. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - increasing atomic mass
   - atomic mass
   - oxide formulas

67. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   - three electrons
   - three
   - 3
68. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Ag
   - silver

69. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Since the Group 18 elements tend not to react with other elements, there were no oxide compounds for Mendeleev to study.
   Group 18 elements are generally unreactive.

70. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - From 0 to +1
   - From zero to one

71. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \[ \text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb} \]

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The glass tube is not a closed system.
   - Gases are entering and leaving the system.
   - The reaction is not reversible under these conditions.

73. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Increase the temperature.
   - Increase the concentration of the hydrogen gas in the tube.
   - Grind the metal oxide to increase its surface area.

74. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Both samples have the same chemical properties.

75. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - aluminum oxide

76. [1] Allow 1 credit for 933 K.

77. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The density of the aluminum is greater than the density of the Al₂O₃ and Na₃AlF₆ mixture.
   - The density of Al(ℓ) is greater.

78. [1] Allow 1 credit for 197 kJ.

79. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - V₂O₅
   - O₂V₂

80. [1] Allow 1 credit.

**Example of a 1-credit response:**

![Diagram of Reaction Coordinate and Potential Energy](attachment:image.png)

81. [1] Allow 1 credit.

**Examples of 1-credit responses:**

\[
\begin{array}{c}
\text{Cl} \\
\text{F} \quad \text{C} \quad \text{F} \\
\text{Cl} \\
\text{F} \quad \text{C} \quad \text{Cl} \\
\text{F}
\end{array}
\]

82. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - halide
   - halocarbon

83. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The polarity of sugar molecules is similar to the polarity of water molecules.
   - Both substances consist of polar molecules.

84. [1] Allow 1 credit for 70.1%. Significant figures do not need to be shown.

85. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The boiling point of the mixture increases as water evaporates because the concentration of dissolved molecules increases.
   - An increase in the concentration of sugar particles increases the boiling point.
The State Education Department / The University of the State of New York

Regents Examination in Physical Setting/Chemistry – June 2013

Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

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Part B–1
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40. 4 41. 4 42. 4
43. 3 44. 1 45. 2
46. 2 47. 3 48. 3
49. 1 50. 1

Part B–2
Allow a total of 15 credits for this part. The student must answer all questions in this part.
51. [1] Allow 1 credit.
   Examples of a 1-credit response:
   
   • Si
   • Si

52. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Interval 3 represents the difference in potential energy between the products and the reactants.
   Interval 3 represents the heat of reaction, +52.4 kJ.

53. [1] Allow 1 credit for 104.8 kJ. Significant figures do not need to be shown.
54. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Increase the temperature.
   Increase the pressure.
   Increase the concentration of H₂(g).
   Increase the surface area of the carbon.

55. [1] Allow 1 credit for marking an appropriate scale. An appropriate scale is linear and allows a trend to be seen.
56. [1] Allow 1 credit for plotting all eight points correctly ± 0.3 grid space. Plotted points do not need to be circled or connected.

57. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   As atomic number increases, there is a decrease in atomic radius.

58. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The radius of a sodium ion is smaller because the sodium atom lost one electron.
   An Na⁺ ion is smaller because it has one fewer electron shell.

59. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Each reactant hydrocarbon molecule has a double carbon-carbon bond.
   There is a multiple carbon-carbon bond in each molecule.
   More hydrogen atoms can be bonded with this hydrocarbon.

60. [1] Allow 1 credit for 56 g/mol. Significant figures do not need to be shown.
61. [1] Allow 1 credit for C₂H₄Br. The order of the elements can vary.
62. [1] Allow 1 credit for 0.20 mol. Significant figures do not need to be shown.
63. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The process requires heat to dissolve NH₄Cl.
   - Energy is absorbed as NH₄Cl dissolves.
   - The energy term is positive on the left side of the equation arrow.
   - The heat of reaction is positive.

64. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The 0.30 M NH₄Cl(aq) sample has more mobile ions in solution.
   - The 0.10 M NH₄Cl solution has a lower concentration of ions.

65. [1] Allow 1 credit for 47 g ± 1 g.

Part C
Allow a total of 20 credits for this part. The student must answer all questions in this part.

66. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - H₂
   - oxygen
   - nitrogen

67. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Methane is a compound consisting of two elements, so it can be broken down by chemical means, but argon is an element, which cannot be broken down.
   - Methane is a compound and argon is an element.

68. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - \[ 338.7 \text{ ppm} = \frac{x}{100.0 \text{ g}} \times 10^6 \]
   \[ \frac{(338.7)(100)}{1000000} \]

69. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The gases in a mixture can be separated by physical means.
   - The gases in the atmosphere are separate elements or compounds that are not chemically combined with each other.
   - The proportions of the gases in the atmosphere can vary.
   - more than one substance

70. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - source of electrical energy
   - battery

71. [1] Allow 1 credit for identifying one metal from the passage that is more active than carbon and one metal from the passage that is less active than carbon.
   - More active than carbon:
     - aluminum
     - Mg
     - Na
   - Less active than carbon:
     - zinc
     - Pb

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - \[ \text{Fe}^{3+} + 3e^- \rightarrow \text{Fe} \]

73. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Boron-11 is about four times more abundant than boron-10.
   - The B-10 is less abundant.

74. [1] Allow 1 credit for \( \frac{32}{5} \text{B} \).

75. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The carbon-11 nucleus has one more proton than the nucleus of boron-11.
   - A B-11 atom has a different number of neutrons than a C-11 atom.

76. [1] Allow 1 credit for 0.000 32 mol or \( 3.2 \times 10^{-4} \text{ mol} \). Significant figures do not need to be shown.

77. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - HC₂H₃O₂(aq)
   - CH₃COOH

78. [1] Allow 1 credit for red.

79. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - \[ \frac{320 \text{ mg} - 325 \text{ mg}}{325 \text{ mg}} \times 100 \]
   \[ (-5)(100) \]
   \[ \frac{325}{325} \]

80. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The average kinetic energy of the water molecules at 7 a.m. is less than the average kinetic energy of the water molecules at 3 p.m.
   - The average kinetic energy of the molecules is greater at 3 p.m.

81. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Heat was transferred from the surroundings to the water in the bottle.
   - The water absorbed energy from the surroundings.

82. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - \[ q = (800. \text{ g})(4.18 \text{ J/g} \cdot °C)(20.5°C - 12.5°C) \]
   \[ (800)(4.18)(8) \]

83. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - fermentation

84. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - \(-\text{OH}\)
   - alcohol group
   - Note: Do not allow credit for hydroxide or OH⁻.

85. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Zymase provides an alternate reaction pathway.
   - A reaction that involves zymase has a lower activation energy.
Regents Examination in Physical Setting/Chemistry – January 2013
Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

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Part A

1. 4  2. 1  3. 1
2. 5  3. 6  2
7. 4  8. 1  9. 3
10. 2  11. 2  12. 3
13. 1  14. 1  15. 3
16. 1  17. 3  18. 4
19. 4  20. 1  21. 2
22. 4  23. 4  24. 4
25. 3  26. 4  27. 4
28. 3  29. 1  30. 2

Part B–1

31. 4  32. 4  33. 1
34. 2  35. 2  36. 4
37. 3  38. 3  39. 4
40. 2  41. 1  42. 3
43. 1  44. 2  45. 2
46. 2  47. 3  48. 1
49. 3  50. 2

Part B–2

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51. [1] Allow 1 credit for 84 g ≥ 2 g.

52. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - single replacement
   - redox

53. [1] Allow 1 credit for \[\frac{2}{3}\text{Al}(s) + \frac{3}{2}\text{CuSO}_4(aq) \rightarrow \frac{3}{2}\text{Al}_2\text{(SO}_4\text{)}_3(aq) + \frac{3}{2}\text{Cu}(s)\].

54. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The products are different substances with different properties from the reactants.
   - There is a loss and gain of electrons by substances in the reaction.

55. [1] Allow 1 credit for 3.81 g.


57. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \(\frac{(85 \text{ g/mol})(1.4 \text{ mol})}{(1.4)(85)}\)

58. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - At standard pressure, the boiling point of the solution is higher than the boiling point of H_2O.
   - Water boils at a lower temperature.

59. [1] Allow 1 credit for 0.70 M. Significant figures do not need to be shown.

60. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The solution can conduct an electric current better than the white solid.
   - The Ca(OH)_2(aq) is a good conductor and Ca(OH)_2(s) is not.

61. [1] Allow 1 credit for calcium hydroxide.

Part C

Allow a total of 20 credits for this part. The student must answer all questions in this part.

62. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Increase the temperature of the water.
   - Increase the surface area of Ca(s).

63. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - H_2O(l) and KCl(aq)
   - KCl and HOH

64. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The number of moles of H^+(aq) ions equals the number of moles of OH^−(aq) ions.
   - The number of hydrogen ions is the same as the number of hydroxide ions.

65. [1] Allow 1 credit for 0.17 M. Significant figures do not need to be shown.

Part D

66. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - K^+
   - Al^{3+}

67. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Dalton’s drawing did not include the element hydrogen.
   - He perceived 5 sulfur atoms, but the formula actually has 2 sulfur atoms.
   - Dalton’s drawing had more aluminum. It did not include water.

68. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \[\frac{12(2 \text{ g/mol} + 16 \text{ g/mol})}{474 \text{ g/mol}} \times 100\]
   \[\frac{216}{474} \times 100\]

69. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Room temperature is above the melting point and below the boiling point of H_2O_2.
   - Room temperature is between −0.4°C and 151°C.
   - −0.4°C < room temperature < 151°C

70. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - More energy is released than absorbed.
   - Heat is a product of the reaction.

71. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The excess pressure due to the production of oxygen gas in the bottle needs to be gradually released.
   - As O_2(g) is produced, the pressure inside of the bottle might increase and the bottle might burst without the pressure-releasing cap.

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Electrons flow from the Al electrode to the Ni electrode.
   - Electrons move left to right through the wire.
73. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \[ \text{Al} \rightarrow 3e^- + \text{Al}^{3+} \]
   \[ 2\text{Al} \rightarrow 2\text{Al}^{3+} + 6e^- \]

74. [1] Allow 1 credit for 6.0 mol. Significant figures do not need to be shown.

75. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   A spontaneous reaction converts chemical energy to electrical energy.
   A battery is not required to provide energy for the cell to operate.

76. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   the organ with a pH of 2

77. [1] Allow 1 credit for yellow.

78. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The lipase provides an alternate reaction pathway that requires less energy.
   lower activation energy


80. [1] Allow 1 credit for ester or esters.

81. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   covalent bonds and ionic bonds
   polar and nonpolar
   single and double

82. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The nuclides used for fusion have smaller atomic masses than nuclides used for fission.
   The nuclides used in fission are many times more massive.
   Fusion particles are lighter.

83. [1] Allow 1 credit for the correct number of protons and the correct number of neutrons for both hydrogen nuclides.

   Example of a 1-credit response:

<table>
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<tr>
<th>Nuclide</th>
<th>Total Number of Protons</th>
<th>Total Number of Neutrons</th>
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<tr>
<td>$^2\text{H}$</td>
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84. [1] Allow 1 credit for $^1\text{H}^\text{n}$.

85. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Fusion produces more energy per gram of reactant.
   The fusion process produces less radioactive waste.
   The fusion reactant material is more readily available.
## Regents Examination in Physical Setting/Chemistry – June 2012

**Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)**

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Chemistry–January 2012

Part A
1. 4
2. 3
3. 2
4. 3
5. 1
6. 2
7. 1
8. 3
9. 3
10. 2
11. 2
12. 1
13. 4
14. 4
15. 4
16. 1
17. 1
18. 4
19. 2
20. 2
21. 2
22. 3
23. 4
24. 2
25. 4
26. 1
27. 4
28. 2
29. 3
30. 3

Part B–1
31. 4
32. 3
33. 1
34. 2
35. 1
36. 4
37. 3
38. 2
39. 4
40. 1
41. 1
42. 3
43. 4
44. 3
45. 1
46. 2
47. 1
48. 4
49. 3
50. 2

Part B–2
Allow a total of 15 credits for this part.
The student must answer all questions in this part.

51. [1] Allow 1 credit for an ionic radius value greater than 181 pm and less than 220 pm.
52. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   A K⁺ ion has three electron shells and an Na⁺ ion has only two.
   A sodium ion has fewer electron shells than a potassium ion.
53. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Particle: electron
   Charge of particle: −1
   Particle: electron
   Charge of particle: negative
54. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   As the elements in Group 1 are considered in order of increasing atomic number, first ionization energy decreases.
   As atomic number increases, first ionization energy decreases.
55. [1] Allow 1 credit for 90°C ± 2°C.
56. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   minute 16
   at 16 minutes
57. [1] Allow 1 credit. Particles of the gas must be drawn farther apart than particles of the liquid.
   Example of a 1-credit response:
   ![Diagram of a 1-credit response]

58. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   A hydrocarbon 1 molecule has two carbon-carbon double bonds and a hydrocarbon 2 molecule has one carbon-carbon triple bond.
   Both hydrocarbons have at least one multiple covalent bond between two carbon atoms.
59. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The molecular formulas of the two hydrocarbons are the same, but the structural formulas are different.
60. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Ni(s) key
   key
   nickel
61. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The cell requires electrical energy for the nonspontaneous reaction to occur.
   The power source causes some Ag(s) atoms to oxidize.
62. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Silver atoms lose electrons and become silver ions in the solution.
   Some of the Ag atoms become Ag⁺ ions.
   Silver atoms are oxidized to silver ions.
63. [1] Allow 1 credit for 3 or three.
64. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   NaNO₃(aq) + H₂O(ℓ)
   HOH + NaNO₃
65. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \( M(A) (35.0 \text{ mL}) = (0.15 \text{ M})(30.0 \text{ mL}) \)
   \[ 0.15 \times \frac{30}{35} \]
Part C

Allow a total of 20 credits for this part. The student must answer all questions in this part.

66. [1] Allow 1 credit for BaCl₂.

67. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   ionic bonds and polar covalent bonds
   covalent and ionic


69. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   When electrons in the ions move from higher energy states to lower energy states, lights of
   specific wavelengths are emitted.
   Light is emitted when electrons return from higher electron shells to lower electron shells.

70. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   unsaturated solution
   unsaturated

71. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The H⁺ ions and the Cl⁻ ions are distributed uniformly throughout the solution.
   There is an even distribution of H⁺(aq) and Cl⁻(aq).

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Fe
   oxygen

73. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Iron reacts with oxygen to form a compound.
   An iron atom can lose three electrons.
   The Fe atoms can form positive ions.

74. [1] Allow 1 credit for \( \frac{2}{2} \text{Fe}(s) + \frac{2}{2} \text{H}_2\text{O}(l) \rightarrow 2 \text{Fe(OH)}_2(s) \).
   Allow credit even if the coefficient “1” is written in front of \( \text{O}_2(g) \).

75. [1] Allow 1 credit for yellow.

76. [1] Allow 1 credit. Significant figures do not need to be shown. Acceptable responses include, but are not limited to:
   \( 4.0 \times 10^{-4} \text{ mol} \)
   \( 0.000 \text{ 40 mol} \)

77. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \( \frac{6(16 \text{ g/mol})}{176 \text{ g/mol}} \times 100 \)
   \( \frac{(96)(100)}{176} \)

78. [1] Allow 1 credit for \( \text{C}_3\text{H}_4\text{O}_3 \). The order of the elements can vary.

79. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   When the pressure in the cylinder is increased,
   the \( \text{SO}_2(g) \) molecules and \( \text{O}_2(g) \) molecules collide more frequently, producing more \( \text{SO}_3(g) \).

80. [1] Allow 1 credit for 196 kJ.

81. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   The concentration of \( \text{SO}_3(g) \) increases.

82. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Nuclear radiation is harmful to all living cells.
   Radioisotopes can cause gene mutations.
   Treatments can cause stomach problems, such as nausea.

83. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   Gamma radiation has greater penetrating power.
   Beta particles have weaker penetrating power.

84. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   \( ^{60}_{28}\text{Ni} \)
   \( ^{60}_{28}\text{Ni} \)
   nickel-60

85. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   15.813 y
   15.8 y
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Part A

1. 3  2. 2  3. 1
2. 3  4. 1  6. 2
3. 3  5. 1  9. 3
4. 1  11. 4  12. 2
5. 4  14. 1  15. 4
6. 3  17. 3  18. 4
7. 1  20. 2  21. 1
8. 3  23. 2  24. 2
9. 4  26. 1  27. 4
10. 1  29. 3  30. 4

Part B–1

31. 1  32. 3  33. 3
34. 2  35. 2  36. 1
37. 2  38. 3  39. 3
40. 4  41. 1  42. 4
43. 2  44. 3  45. 4
46. 3  47. 4  48. 2
49. 3  50. 4

Part B–2

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   A U-235 atom has 92 protons and 143 neutrons, and a U-238 atom has 92 protons and 146 neutrons.

   A U-235 atom and a U-238 atom have the same number of protons but a different number of neutrons.

52. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   When electrons in an excited state return to a lower energy state, specific amounts of energy are emitted. These energies are associated with specific wavelengths of light that are characteristic of the bright-line spectrum of an element.

   Energy is emitted when excited electrons fall back to lower shells.

53. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   lithium and strontium

   Sr and Li

54. [1] Allow 1 credit for 2 or two.

55. [1] Allow 1 credit for marking an appropriate scale. An appropriate scale is linear and allows a trend to be seen.

56. [1] Allow 1 credit for plotting all four points correctly ± 0.3 grid space. Plotted points do not need to be circled or connected.

57. [1] Allow 1 credit for 117 pm ± 2 pm or for a response consistent with the student’s graph.

58. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   As the atomic number of elements in Group 2 increases, the ionic radius increases.

   The ionic radius increases.

59. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The valence electron shell of a Group 2 atom is lost when it becomes an ion.

   A Group 2 ion has two fewer electrons than the atom from which it was formed.

60. [1] Allow 1 credit for +5.

61. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   The gaseous product is more disordered than the solid reactant.

   The solid reactant is more ordered than the products.

62. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   −0.27 mol/L

   0.27 mol/L

63. [1] Allow 1 credit. Acceptable responses include, but are not limited to:

   Between time \( t_1 \) and time \( t_2 \), the concentrations of the reactants and the concentrations of the products are no longer changing.

   The concentrations of the reactants and the products remain constant.

   The concentration of each reactant is 0.73 mol/L, and the concentration of each product is 0.27 mol/L.
64. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - addition
   - halogenation
   - bromination

65. [1] Allow 1 credit for alkene or alkenes.

Part C
Allow a total of 20 credits for this part. The student must answer all questions in this part.
66. [1] Allow 1 credit for
   \[ 3 \text{ O}_2(g) \xrightarrow{\text{electrolysis}} 2 \text{ O}_3(g). \]

67. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - nonpolar covalent
   - covalent
   - double covalent

68. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Both atoms in an O\textsubscript{2} molecule have achieved a noble gas electron configuration.
   - An oxygen atom does not have a stable octet of valence electrons.

69. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - fractional distillation
   - distillation

70. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - methane
   - ethane
   - propane
   - butane
   Weakest intermolecular forces
   Strongest intermolecular forces
   - CH\textsubscript{4}
   - C\textsubscript{2}H\textsubscript{6}
   - C\textsubscript{3}H\textsubscript{8}
   - C\textsubscript{4}H\textsubscript{10}

71. [1] Allow 1 credit for NaHCO\textsubscript{3} or NH\textsubscript{4}Cl.

72. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The electronegativity difference is 1.4 for H and O, which is higher than the 0.9 for H and N.
   - The difference in electronegativity between hydrogen and oxygen is greater than that for hydrogen and nitrogen.

73. [1] Allow 1 credit.
   Examples of 1-credit responses:

\[
\begin{align*}
\text{Example 1:} & \quad \text{H} \quad \text{H} \\
\text{Example 2:} & \quad \text{H} \\
\text{Example 3:} & \quad \text{H} \\
\end{align*}
\]

74. [1] Allow 1 credit for \textit{two} acceptable responses.
   Mixture 1: homogeneous
   - Mixture 2: heterogeneous

75. [1] Allow 1 credit for 2.02 cm\textsuperscript{3}. Significant figures do not need to be shown.

76. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Heat mixture 1 until all the water evaporates.
   - Allow the water to evaporate.

77. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The solution is no longer blue green.
   - A reddish-brown solid is formed.

78. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Heat the solution before adding the aluminum foil.
   - Increase the concentration of the CuCl\textsubscript{2} solution.
   - Cut the Al foil into even smaller pieces.

79. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Thoroughly wash the lab equipment and return it to its proper storage place.
   - Dispose of the chemicals as directed by the teacher.
   - Wash hands before leaving the lab room.

80. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - The beverage is acidic because its pH value is below 7.
   - A pH of 3 is in the acid range on the pH scale.

81. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - bromthymol blue
   - bromcresol green
   - thymol blue

82. [1] Allow 1 credit for \textit{6} or six.

83. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - Polonium-210 is used to eliminate static electricity in machinery.
   - Removes dust from camera lenses

84. [1] Allow 1 credit. Acceptable responses include, but are not limited to:
   - lead-206

85. [1] Allow 1 credit for 3.5 mg.
# Regents Examination in Physical Setting/Chemistry
## June 2011

Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

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Acknowledgments

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Prentice Hall Brief Review

Chemistry: The Physical Setting

Answer Key