June 2017

PHYSICAL SETTING
CHEMISTRY

Regents Review
Practice Tests

Answers Written By:

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Science Teacher – Retired

STUDENTS

One of the best ways to raise your Physical Setting/Chemistry Regents Exam grade is to diligently do four previous exams with complete comprehension. When you are done, you will have a working understanding of approximately 350 questions and their supporting concepts. Questions related to these concepts will appear on the exam. This is the purpose of this review book. The trick is to do the exams in earnest; taking your time, checking over our brief but concise explanations until they make sense, and revisiting the ones you answer incorrectly a few days later to check your understanding of the correct answer.

Timing is essential. Don't wait until the last week. We suggest that you start working on these exams early. A good pace to set is 20 to 30 questions a day. Star the ones you need to revisit, underline or highlight important information, and have a good knowledge of what is in the Reference Tables -RT. Many answers are based on information in the Reference Tables.

Chemistry is a commencement level science course, so a good deal of effort is required. Put in the effort, work hard, and your grade will improve.

Good Luck!

PHYSICAL SETTING
REGENTS
CHEMISTRY

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EXAM **PAGE**

June 2017
Part A
Answer all questions in this part.

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

1. Which statement describes the structure of an atom?
(1) The nucleus contains positively charged electrons.
(2) The nucleus contains negatively charged protons.
(3) The nucleus has a positive charge and is surrounded by negatively charged electrons.
(4) The nucleus has a negative charge and is surrounded by positively charged electrons. 1_____

2. Which term is defined as the region in an atom where an electron is most likely to be located?
(1) nucleus (2) orbital (3) quanta (4) spectra 2_____

3. What is the number of electrons in an atom of scandium?
(1) 21 (2) 24 (3) 45 (4) 66 3_____

4. Which particle has the *least* mass?
(1) a proton (3) a helium atom
(2) an electron (4) a hydrogen atom 4_____

5. Which electron transition in an excited atom results in a release of energy?
(1) first shell to the third shell
(2) second shell to the fourth shell
(3) third shell to the fourth shell
(4) fourth shell to the second shell 5_____

6. On the Periodic Table, the number of protons in an atom of an element is indicated by its
(1) atomic mass (3) selected oxidation states
(2) atomic number (4) number of valence electrons 6_____

7. Which type of formula shows an element symbol for each atom and a line for each bond between atoms?
(1) ionic (2) structural (3) empirical (4) molecular 7_____

8. What is conserved during all chemical reactions?
(1) charge (2) density (3) vapor pressure (4) melting point 8_____

9. In which type of reaction can two compounds exchange ions to form two different compounds?
(1) synthesis (3) single replacement
(2) decomposition (4) double replacement 9_____

10. At STP, two 5.0-gram solid samples of different ionic compounds have the same density. These solid samples could be differentiated by their
(1) mass (2) volume (3) temperature (4) solubility in water 10____

11. What is the number of electrons shared between the atoms in an I_2 molecule?
(1) 7 (2) 2 (3) 8 (4) 4 11____

12. Which substance has nonpolar covalent bonds?
(1) Cl_2 (2) SO_3 (3) SiO_2 (4) CCl_4 12____

13. Compared to a potassium atom, a potassium ion has
(1) a smaller radius (3) fewer protons
(2) a larger radius (4) more protons 13____

14. Which form of energy is associated with the random motion of particles in a gas?
(1) chemical (2) electrical (3) nuclear (4) thermal 14____

15. The average kinetic energy of water molecules *decreases* when
(1) $H_2O(\ell)$ at 337 K changes to $H_2O(\ell)$ at 300. K
(2) $H_2O(\ell)$ at 373 K changes to $H_2O(g)$ at 373 K
(3) $H_2O(s)$ at 200. K changes to $H_2O(s)$ at 237 K
(4) $H_2O(s)$ at 273 K changes to $H_2O(\ell)$ at 273 K 15____

16. The joule is a unit of
(1) concentration (2) energy (3) pressure (4) volume 16____

17. Compared to a sample of helium at STP, the same sample of helium at a higher temperature and a lower pressure
(1) condenses to a liquid (3) forms diatomic molecules
(2) is more soluble in water (4) behaves more like an ideal gas 17____

18. A sample of a gas is in a sealed, rigid container that maintains a constant volume. Which changes occur between the gas particles when the sample is heated?
(1) The frequency of collisions increases, and the force of collisions decreases.
(2) The frequency of collisions increases, and the force of collisions increases.
(3) The frequency of collisions decreases, and the force of collisions decreases.
(4) The frequency of collisions decreases, and the force of collisions increases. 18____

19. At STP, which gaseous sample has the same number of molecules as 3.0 liters of $N_2(g)$?
(1) 6.0 L of $F_2(g)$ (3) 3.0 L of $H_2(g)$
(2) 4.5 L of $N_2(g)$ (4) 1.5 L of $Cl_2(g)$ 19____

20. Distillation of crude oil from various parts of the world yields different percentages of hydrocarbons. Which statement explains these different percentages?
(1) Each component in a mixture has a different solubility in water.
(2) Hydrocarbons are organic compounds.
(3) The carbons in hydrocarbons may be bonded in chains or rings.
(4) The proportions of components in a mixture can vary. 20____

21. In which 1.0-gram sample are the particles arranged in a crystal structure?
(1) $CaCl_2(s)$ (2) $C_2H_6(g)$ (3) $CH_3OH(\ell)$ (4) $CaI_2(aq)$ 21____

22. When a reversible reaction is at equilibrium, the concentration of products and the concentration of reactants must be
(1) decreasing (2) increasing (3) constant (4) equal 22____

23. In chemical reactions, the difference between the potential energy of the products and the potential energy of the reactants is equal to the
(1) activation energy (3) heat of reaction
(2) ionization energy (4) heat of vaporization 23____

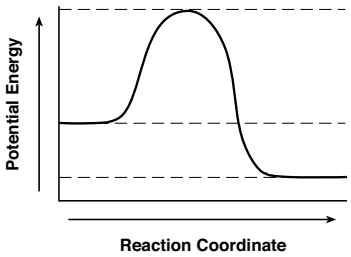
24. What occurs when a catalyst is added to a chemical reaction?
(1) an alternate reaction pathway with a lower activation energy
(2) an alternate reaction pathway with a higher activation energy
(3) the same reaction pathway with a lower activation energy
(4) the same reaction pathway with a higher activation energy 24____

76. State how increasing the temperature of the H_2O_2 affects the rate of the reaction. [1] _____

_____

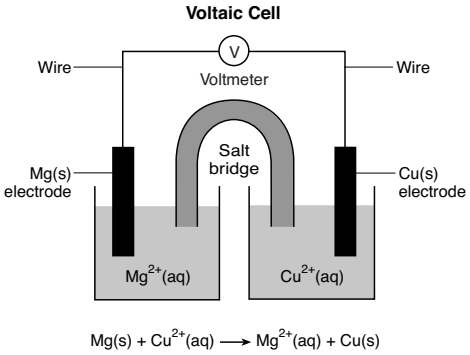
_____

77. On the potential energy diagram, draw a double-headed arrow (↕) to indicate the interval that represents the heat of reaction. [1]



Base your answers to questions 78 through 82 on the information below and on your knowledge of chemistry.

During a laboratory activity, appropriate safety equipment is used and safety procedures are followed. A student constructs a voltaic cell with magnesium and copper electrodes. The diagram and net ionic equation represent this cell and the reaction that occurs.



$Mg(s) + Cu^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Cu(s)$

78. Identify the subatomic particles that flow through the wire as the cell operates. [1]

_____

79. Compare the number of electrons lost to the number of electrons gained during the reaction in the operating cell. [1]

_____

_____

_____

80. State the form of energy that is converted to electrical energy in the operating cell. [1] _____

81. Write a balanced equation for the half-reaction that occurs in the copper half-cell when the cell operates. [1]

_____

82. Identify one metal from Table *J* that is more easily oxidized than Mg. [1] _____

ANSWERS AND EXPLANATIONS

June 2017
Part A

1. 3 The nucleus of all atoms consists of two major subatomic particles: protons and neutrons. A proton possesses a unit positive (1+) charge, while a neutron has no charge (0). Thus the nucleus is always positive in charge. In orbitals, negatively charge electrons surround the nucleus.

2. 2 Electrons, fast moving negatively charged particles, are found outside the nucleus. They are located in orbitals or energy levels that are at different locations around the nucleus. These orbitals are the regions where electrons are most likely to be found.

3. 1 In a neutral atom, the number of electrons equals the number of protons. The atomic number is the number of protons that an element possesses. The Periodic Table gives the atomic number of scandium as 21. Therefore, a scandium atom will have 21 electrons.

4. 2 The mass of an electron is negligible compared to a proton or a neutron. The masses of the particles in an atom are given on Table O, where a beta particle is an electron.

5. 4 When an atom gains enough energy, an electron(s) is able to move to a higher energy level. When the electron(s) return from a higher energy state to a lower energy state, a specific amount of energy is emitted in the form of light.

6. 2 The atomic number is the number of protons in an atom. It is the atomic number that identifies the atom.

7. 2 A structural formula shows the arrangement and the bonds of the atoms in a molecule. In a structural formula diagram, a singled dash between two atoms represents a pair of shared electrons, being a covalent bond.

8. 1 In all chemical reactions there is conservation of mass, charge and energy.

9. 4 In a double replacement reaction, both reactants exchange ions to form two different compounds or products. An example of a double replacement reaction is: $KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(\ell)$. In a single replacement reaction, only one different compound is formed.

10. 4 The definition of density is mass per unit volume (see Table T). Because the two substances have the same mass and density, they must have the same volume. The two samples are at the same temperature (standard temperature). Therefore, the only choice given that can differentiate between the two is the solubility in water.

11. 2 The electron configuration of iodine (I) is 2-8-18-18-7. The valance shell needs one electron to become stable. In the diatomic element I_2, each iodine atom shares two electrons to fill their valance shell.

12. 1 The difference in electronegativity (ΔEN) between two elements is used to determine the type of bond formed between those elements. The ΔEN between the chlorine atoms in Cl_2, a diatomic molecule, is 0, produces nonpolar covalent bonds.

13. 1 When potassium atom (K) undergoes oxidation by losing its 1 valence electron, a positively charged ion results (K^{+1}). By losing its one valence electron, the entire valence shell is lost, decreasing the radius of the atom.

14. 4 Thermal energy comes from the movement of atoms and molecules in matter. Thermal or heat energy is the kinetic energy of this motion. In gases, the faster the random motion of the particles, the greater the thermal energy.

15. 1 By definition, temperature is a measure of the average kinetic energy of the particles in a substance. A decrease in temperature causes a decrease in the average kinetic energy of the system. Only choice 1 is the temperature decreasing.

16. 2 On Table D, find the quantity energy. The name of the unit for energy is the joule (J).

17. 4 An ideal gas is one that conforms exactly to the assumptions of the kinetic theory. This theory states that gas particles have no attraction for one another, are in constant random motion, and undergo perfectly elastic collisions (no energy loss due to their collisions). This is best accomplished by having the gas under low pressure and high temperature.

18. 2 When the volume is constant and heat is applied to a gaseous substance, the gas particles average kinetic energy increases, causing the particles to move faster. This, in turn, causes the frequency and the force of collisions to increase. This situation causes an increase in the pressure within the rigid container.

19. 3 Equal volumes of all gases at the same temperature and pressure have equal numbers of particles. This is the Avogadro's Principle. Therefore, at STP, 3.0 L of $H_2(g)$ contains the same number of molecules as 3.0 L of $N_2(g)$.

48. 1 Open to Table M. Methyl orange will undergo a change of color from red to yellow in a pH range of 3.1- 4.4. Above this range, this indicator will remain yellow.

49. 3 The pH scale indicates the concentration of the hydronium ions [(H_3O^+), see Table E] in a solution. This scale is based on the logarithmic scale. A decrease of 1 pH unit (becoming more acidic) represents a 10-fold increase in hydronium ion concentration. A decrease of 2 pH units represents 100*x* ($10 \times 10 = 10^2$) increase in the concentration of hydronium ions.

50. 1 Nuclear reactions release, by far, more energy per mole of reactant than any chemical reaction. In a nuclear reaction, a small amount of mass is converted to a large amount of energy according to Einstein's equation, $E = mc^2$.

Part B-2

51. Answer: 3

Explanation: Li-7 is an isotope of lithium, where 7 represents its atomic mass (P + N). Open to the Periodic Table. Lithium's atomic number (number of protons) is 3. In neutral atoms, electrons equal protons.

52. Acceptable responses include, but are not limited to:
The energy of an electron in the first shell is less than the energy of an electron in the second shell.
or The second shell electron has greater energy.

Explanation: The farther electrons are from the nucleus of an atom, the greater the energy they possess.

53. Acceptable responses include, but are not limited to:

$$(6.015\text{ u})(0.0759) + (7.016\text{ u})(0.9241)$$

or $$\frac{(7.59)(6.015) + (92.41)(7.016)}{100}$$

or $$(7.59\%)(6.015) + (92.41\%)(7.016)$$

Explanation: The atomic mass of an element is the weighted average mass of the naturally occurring isotopes of that element. This is obtained by taking the sum of the products of the percentages and mass of each isotope. The above examples are the mathematical set-ups to obtain the correct average atomic mass of the isotopes of lithium.

54. Acceptable responses include, but are not limited to:
From left to right in Period 3, the atomic radius generally decreases.
or The atomic radius decreases from Na to Cl across Period 3.
or Radii decrease

Explanation: The graph shows this decreasing trend for the atomic radii from Na to Cl.

55. Acceptable responses include, but are not limited to:
Aluminum atoms and sulfur atoms have a different number of outermost shell electrons per atom.
or An Al atom has 3 valence electrons and an S atom has 6 valence electrons.
or Aluminum tends to lose valence electrons and sulfur tends to gain valence electrons.
or Aluminum tends to transfer valence electrons while sulfur tends to share valence electrons.

Explanation: Elements in the same group have similar chemical properties due to having the same number of valence electrons. Al is located in Group 13 and is shown to have 3 valance electrons. S is located in Group 16 and is shown to have 6 valence electrons. These two elements have different chemical properties and would react differently in chemical reactions.

56. Answer: Na *or* sodium

Explanation: In compounds, the total oxidation state must equal zero making the compound neutral. The Periodic Table shows the oxidation number for oxygen is –2. In the formula X_2O, element X must have an oxidation number of +1, therefore 2X would have a total oxidation number of +2. Now the total oxidation states (numbers) will be equal. Open to the Periodic Table. Na being in Period 3 has an oxidation state of +1. When Na reacts with O, the ionic product would be Na_2O.

57. Acceptable responses include, but are not limited to:
A Be^{2+} ion is smaller because it has only 1 shell of electrons and a Be atom has 2 shells of electrons.
or The Be atom has 4 electrons and the Be^{2+} ion has 2 electrons.
or A Be^{2+} ion forms when the Be atom loses 2 electrons.
or A beryllium ion has two fewer electrons.

Note: No credit is awarded for a response indicating that the Be^{2+} ion lost electrons.

Explanation: When beryllium undergoes oxidation by losing its 2 valence electrons, a positively charged ion results, Be^{2+}. By losing two electrons, the entire valence shell of Be is lost (see the Periodic Table), causing a decrease in the radius of the Be atom.

58. Answer:  *or*  *or* 
Note: The position of the electrons may vary

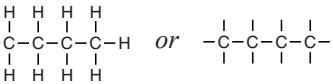
Explanation: In a Lewis electron-dot diagram, valence electrons are represented by dots or **x**'s. Boron, having 3 valence electrons would have 3 dots (or **x**'s) located around its symbol.

59. Acceptable responses include, but are not limited to:
The molecular formulas for the two compounds are the same, but the structural formulas are different.
or Both molecules have the same number of C atoms and the same number of H atoms, but have a different arrangement of atoms.

or Both compounds are C_4H_8, but have different structures.

or Both compounds are C_4H_8, but one has the double bond on an end carbon, and the other compound has the double bond between the middle carbons.

Explanation: Isomers are compounds which have the same molecular formula (number of atoms of each element), but exhibit different structural formulas. Structural formulas show the arrangement of the atoms in the molecule and different structural formulas produce different chemical and physical properties. The molecular formula of 1-butene and 2-butene is C_4H_8, but the location of the double bond would be different positions on the carbon chain as indicated by the numbers 1 and 2, making these molecules isomers.

60. Answer:  *or*

Note: No credit is awarded if in the first diagram only some of the H atoms bonded to C atoms are shown.

Explanation: The organic molecule C_4H_8 is a member of the alkene series (see Table Q – C_nH_{2n}) having a double bond. A hydrogen atom, being a reactive nonmetal, can break the carbon-carbon double bond and form two new single covalent bonds each with a hydrogen atom. This process is called addition. The product produced is butane (C_4H_{10}) an alkane (see Table Q) a saturated hydrocarbon having only single bonds.

61. Answer: 3 *or* three

Explanation: The volume of the HCl(aq) is stated as 24.0 mL. All non-zero digits are significant. Zeros are significant when they follow a number and are to the right of a decimal. Zeros in front of a number are not significant. The value 24.0 has 3 significant figures, 2 to the left of the decimal and 1 to the right of the decimal.

62. Answer: OH^- *or* hydroxide *or* hydroxide ion

Note: No credit is awarded for OH or hydroxyl or hydroxyl ion.

Explanation: When dissolved in water, sodium hydroxide NaOH(aq) dissociates (ionizes) producing OH^-(aq) and Na^+(aq) ions. As a result, the hydroxide ion concentration in the water increases producing a basic solution.

63. Acceptable responses include, but are not limited to:
The number of hydronium ions is the same as the number of hydroxide ions.

or The number of moles of H_3O^+(aq) ions equals the number of moles of OH^-(aq) ions.

or moles of H^+ = moles of OH^- *or* equal *or* same

Explanation: An aqueous solution is acidic due to hydronium ions (H_3O^+) and is basic due to hydroxide ions (OH^-). In the complete neutralization of an acid and a base, the resulting solution is neutral, having a pH of 7. When this occurs, the moles of H_3O^+(aq) will equal the moles of OH^-(aq).

64. Answer: $NaCl(aq) + H_2O(\ell)$ *or* NaCl + HOH

Explanation: In the neutralization of an acid (HCl) and a base (NaOH), the products are salt (NaCl) and water.

65. Answer: 0.12 M *or* .12 M

Explanation: Open to Table T and locate the Titration equation. In an acid-base titration procedure, a solution of known concentration (the standard) is used to determine the unknown concentration of an acid or base by reaching neutralization as shown by an indicator.
The acid is HCl(aq) and the base is NaOH(aq).
Equation: $M_AV_A = M_BV_B$
Given values: V_A =24.0 mL, M_B = 0.18 M, V_B = 16.0 mL
Unknown quantity: M_{HCl}
Substituting: $(M_{HCl})(24.0\text{ mL}) = (0.18\text{ M})(16.0.\text{ mL})$
Solving: $M_{HCl} = \dfrac{(0.18\text{ M})(16.0\text{ mL})}{24.0\text{ mL}} = 0.12\text{ M}$

66. Acceptable responses include, but are not limited to:
$\dfrac{840\text{ g}}{32\text{ g/mol}}$ *or* $840\text{ g} \times \dfrac{1\text{ mol}}{32\text{ g}}$ *or* $\dfrac{32\text{ g}}{1\text{ mol}} = \dfrac{840\text{ g}}{x}$ *or* $\dfrac{840}{32}$

Explanation: The gram-formula mass of $O_2(g)$ is 32 g/mol. The average person needs 840 g of oxygen. Open to Table T – Mole Calculation.
Substituting: number of moles = 840 g/32 g/mol.

67. Acceptable responses include, but are not limited to:
From –2 to 0 *or* From 2– to 0 *or* From negative two to zero

Note: No credit is awarded when the 2 is without a minus sign.

Explanation: In a water molecule, the two hydrogen atoms each share an electron with the oxygen atom. This produces the oxidation states of H^+ and O^{2-}. In this reaction, oxygen undergoes oxidation, losing electrons to the hydrogen atoms resulting in an increase in the oxidation number. The resulting O_2 molecule is neutral in charge.

68. Answer: 60. mol *or* 60 mol

Explanation: The coefficients in front of the reactants and products on both sides of a balanced equation represent the number of moles of each. The given balanced equation shows when 2 moles of $H_2O(\ell)$ undergo electrolysis, 1 mole of $O_2(g)$ is produced. To maintain this ratio (2:1), when 120 moles of $H_2O(\ell)$ reacts, it produces 60 moles of $O_2(g)$.

69. Answer: 11% *or* any value from 11% to 11.223%, inclusive.

Explanation: From the Periodic Table, hydrogen has a mass of 1 g/mol, the mass of the two atoms of hydrogen would be 2 g/mol. For H_2O, the gram formula mass is 18 g/mol. Open to Table T – Percent Composition.
Substituting and solving: % composition by mass = $\dfrac{2\text{ g/mol}}{18\text{ g/mol}} \times 100 = 11\%$

70. Answer: $2\ LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$

Note: Credit is awarded if the coefficient "1" is written in front of CO_2, Li_2CO_3 and/or H_2O.

Explanation: When balanced with the smallest whole-number coefficients, a balanced equation has equal numbers of atoms of each element on both sides. This balanced equation shows that both the reactants and products have 2 atoms of Li, 2 atoms of H, and 4 atoms of O.

71. Answer: 5.0 ppm *or* 5 ppm

Explanation: Open to Table T. The Concentration section gives the parts per million equation. Mass of the part is grams of $CaCO_3$ = 0.00075 g; the mass of the whole is the mass of the tap water sample, 150. g.

Substituting: $\text{ppm} = \frac{0.00075\ \text{g}}{150.\ \text{g}} \times 1{,}000{,}000 = 0.000005 \times 1{,}000{,}000 = 5.0\ \text{ppm}$

72. Acceptable responses include, but are not limited to:
The water contains $Ca^{2+}(aq)$, $Mg^{2+}(aq)$, and $CO_3^{2-}(aq)$ that can move.
or There are mobile ions in the solution.
or Tap water contains aqueous ions that allow electrical conductivity.
or The water contains dissolved ions.

Explanation: A substance that conducts an electric current when dissolved in water is called an electrolyte. The tap water contains dissolved ions that conduct electricity.

73. Answer:  *or* 

Explanation: Water molecules are polar molecules. This is caused by an unbalance of charges, causing one side of the water molecule to be positive and the other side to be negative. The hydrogen side of the water molecule possesses a partial positive charge, while the oxygen side possesses a partial negative charge. The negative oxygen side of the water molecules will be attracted to the positive ion, Ca^{2+}. An acceptable answer must show this orientation.

74. Acceptable responses include, but are not limited to:
Heat is shown on the product side on the equation.
or The energy term is on the right side of the equation.
or Heat is a product.

Explanation: An exothermic reaction is one that produces or releases energy. When included in a chemical equation, the heat is shown on the product side.

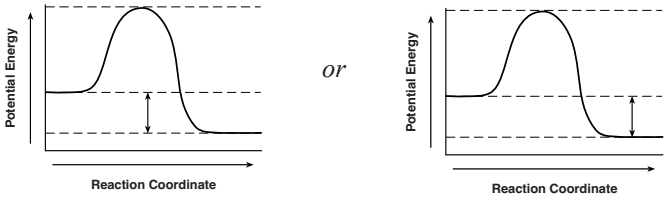
75. Answer: One substance reacts to become two different substances.
or A compound becomes a compound and an element.

Explanation: Chemical decomposition occurs when a compound is broken down into its elements or simpler compounds. In this equation, hydrogen peroxide is decomposing into water and oxygen. The opposite reaction of decomposition is synthesis.

76. Acceptable responses include, but are not limited to:
The increase in temperature of the reactant will increase the reaction rate.
or The reaction will happen faster after the temperature increases.
or higher temperature, faster rate

Explanation: To decompose hydrogen peroxide, energy is absorbed in order to break the bonds. If the temperature is increased, more energy is available to break the bonds, thus the rate of reaction increases.

77. Acceptable responses include, but are not limited to:



Explanation: The reactants involved in a chemical reaction will be at a specific potential energy. After the reaction, the products will be at a different potential energy. By definition, the difference between the potential energy of the products and that of the reactants is the heat of reaction (ΔH); the double arrow shows this ΔH. Remember, in exothermic reactions the potential energy of the products is lower than the potential energy of the reactants.

78. Answer: electrons *or* electron *or* e^-
Note: No credit allow for the e without the minus sign (–).

Explanation: A voltaic cell (electrochemical cell) involves a spontaneous redox reaction, producing an electric current. In a redox reaction, electrons are transferred from the anode (the Mg electrode) to the cathode (the Cu electrode) via the wire.

79. Acceptable responses include, but are not limited to: The number of electrons lost by Mg(s) equals the number of electrons gained by $Cu^{2+}(aq)$.
or The number of electrons lost and gained is the same.
or same
or same rate

Explanation: In a voltaic cell, a spontaneous redox reaction occurs. To maintain this chemical reaction, there must be an equal exchanges of ion (electrons) from the anode and the cathode.

80. Answer: chemical potential energy *or* chemical *or* potential

Explanation: In a voltaic cell, a spontaneous chemical redox reaction occurs producing an electric current. This represents a conversion of chemical energy to electrical energy.

81. Acceptable responses include, but are not limited to:
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ *or* $Cu^{+2} + 2e^- \rightarrow Cu$
Note: No credit allowed for the e without the minus sign (-).

Explanation: In the copper half-cell, the Cu^{+2} ion is undergoing reduction, gaining 2 electrons while decreasing its oxidation state to Cu°.

82. Acceptable responses include, but are not limited to:
Na, Ca, Sr, Ba, Cs, K, Rb, Li

Explanation: Table J is based on the chemical activities of selected elements (metals and nonmetals). In a chemical reaction, a more active metal which is higher up on Table J, will replace a less active metal when placed in an aqueous solution containing the ions of the less active metal. The more active metal undergoes oxidation, losing electrons. Thus, a metal listed above Mg on Table J will be more easily oxidized than Mg.

83. Answer: 12.5% *or* 0.125 *or* 1/8

Explanation: The half-life of Bk-249 is given as 320 days. The original mass of the radioactive element is reduced by ½ for each half-life.

The original mass at 0 half-life	= 100%	0 days
1^{st} half-life	= 50%	320 days
2^{nd} half-life	= 25%	640 days
3^{rd} half-life	= 12.5%	960 days

84. Acceptable responses include, but are not limited to:
Protons: Both atoms contain 117 protons.
Neutrons: ^{294}Uus has 177 neutrons and ^{293}Uus has 176 neutrons.

or

Protons: same number
Neutrons: different number

Explanation: Open to the Periodic Table and locate element 117 Uus. The atomic number (#P) of all isotopes of Uus is 117. Therefore, both isotopes have the same number of protons, but different numbers of neutrons. To determine the number of neutrons in an element's nucleus, subtract the atomic number from the atomic mass. The number of neutrons in 294Uus nucleus is: 294 – 117 = 177. The number of neutrons in 293Uus nucleus is: 293 – 117 = 176.

85. Answers: $^{290}_{115}$Uup *or* Uup-290 *or* ununpentium-290 *or* ^{290}Uup

Note: Moscoviun-290 ($^{290}_{115}$Mc) is an acceptable answer.

Explanation: In a nuclear equation, the sum of the atomic (charge) numbers on each side must be equal and the sum of the mass numbers on each side must be equal. Uus-294 spontaneously emits an alpha particle, a helium nucleus (see Table O), causing a decrease of 2 of the atomic number and a decrease of 4 of the atomic mass of Uus. The resulting new element has an atomic number of 115 and mass number of 290. From the Periodic Table, the new element that has 115 protons is Uup.

PHYSICAL SETTING CHEMISTRY
REFERENCE TABLES — 2011 EDITION

Contents

Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

Table B
Physical Constants for Water

Heat of Fusion	334 J/g
Heat of Vaporization	2260 J/g
Specific Heat Capacity of $H_2O(\ell)$	4.18 J/g•K

Table C
Selected Prefixes

Factor	Prefix	Symbol
10^{3}	kilo-	k
10^{-1}	deci-	d
10^{-2}	centi-	c
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p

Table D
Selected Units

Symbol	Name	Quantity
m	meter	length
g	gram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
min	minute	time
h	hour	time
d	day	time
y	year	time
L	liter	volume
ppm	parts per million	concentration
M	molarity	solution concentration
u	atomic mass unit	atomic mass

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
^{198}Au	2.695 d	β^-	gold-198
^{14}C	5715 y	β^-	carbon-14
^{37}Ca	182 ms	β^+	calcium-37
^{60}Co	5.271 y	β^-	cobalt-60
^{137}Cs	30.2 y	β^-	cesium-137
^{53}Fe	8.51 min	β^+	iron-53
^{220}Fr	27.4 s	α	francium-220
^{3}H	12.31 y	β^-	hydrogen-3
^{131}I	8.021 d	β^-	iodine-131
^{37}K	1.23 s	β^+	potassium-37
^{42}K	12.36 h	β^-	potassium-42
^{85}Kr	10.73 y	β^-	krypton-85
^{16}N	7.13 s	β^-	nitrogen-16
^{19}Ne	17.22 s	β^+	neon-19
^{32}P	14.28 d	β^-	phosphorus-32
^{239}Pu	2.410×10^4 y	α	plutonium-239
^{226}Ra	1599 y	α	radium-226
^{222}Rn	3.823 d	α	radon-222
^{90}Sr	29.1 y	β^-	strontium-90
^{99}Tc	2.13×10^5 y	β^-	technetium-99
^{232}Th	1.40×10^{10} y	α	thorium-232
^{233}U	1.592×10^5 y	α	uranium-233
^{235}U	7.04×10^8 y	α	uranium-235
^{238}U	4.47×10^9 y	α	uranium-238

Source: *CRC Handbook of Chemistry and Physics*, 91st ed., 2010–2011, CRC Press

Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	^4_2He or $^4_2\alpha$	α
beta particle	$^0_{-1}e$ or $^0_{-1}\beta$	β^-
gamma radiation	$^0_0\gamma$	γ
neutron	^1_0n	n
proton	^1_1H or ^1_1p	p
positron	$^0_{+1}e$ or $^0_{+1}\beta$	β^+

Table P
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C_nH_{2n+2}	ethane	
alkenes	C_nH_{2n}	ethene	
alkynes	C_nH_{2n-2}	ethyne	

Note: n = number of carbon atoms

Table R
Organic Functional Groups

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	—F (fluoro-) —Cl (chloro-) —Br (bromo-) —I (iodo-)	$R{-}X$ (X represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	$-OH$	$R{-}OH$	$CH_3CH_2CH_2OH$ 1-propanol
ether	$-O-$	$R{-}O{-}R'$	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde			 propanal
ketone			 2-pentanone
organic acid			 propanoic acid
ester			 methyl propanoate
amine			$CH_3CH_2CH_2NH_2$ 1-propanamine
amide			 propanamide

Note: R represents a bonded atom or group of atoms.

Table S
Properties of Selected Elements

Atomic Number	Symbol	Name	First Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling* Point (K)	Density** (g/cm^3)	Atomic Radius (pm)
1	H	hydrogen	1312	2.2	14	20.	0.000082	32
2	He	helium	2372	—	—	4	0.000164	37
3	Li	lithium	520.	1.0	454	1615	0.534	130.
4	Be	beryllium	900.	1.6	1560.	2744	1.85	99
5	B	boron	801	2.0	2348	4273	2.34	84
6	C	carbon	1086	2.6	—	—	—	75
7	N	nitrogen	1402	3.0	63	77	0.001145	71
8	O	oxygen	1314	3.4	54	90.	0.001308	64
9	F	fluorine	1681	4.0	53	85	0.001553	60.
10	Ne	neon	2081	—	24	27	0.000825	62
11	Na	sodium	496	0.9	371	1156	0.97	160.
12	Mg	magnesium	738	1.3	923	1363	1.74	140.
13	Al	aluminum	578	1.6	933	2792	2.70	124
14	Si	silicon	787	1.9	1687	3538	2.3296	114
15	P	phosphorus (white)	1012	2.2	317	554	1.823	109
16	S	sulfur (monoclinic)	1000.	2.6	388	718	2.00	104
17	Cl	chlorine	1251	3.2	172	239	0.002898	100.
18	Ar	argon	1521	—	84	87	0.001633	101
19	K	potassium	419	0.8	337	1032	0.89	200.
20	Ca	calcium	590.	1.0	1115	1757	1.54	174
21	Sc	scandium	633	1.4	1814	3109	2.99	159
22	Ti	titanium	659	1.5	1941	3560.	4.506	148
23	V	vanadium	651	1.6	2183	3680.	6.0	144
24	Cr	chromium	653	1.7	2180.	2944	7.15	130.
25	Mn	manganese	717	1.6	1519	2334	7.3	129
26	Fe	iron	762	1.8	1811	3134	7.87	124
27	Co	cobalt	760.	1.9	1768	3200.	8.86	118
28	Ni	nickel	737	1.9	1728	3186	8.90	117
29	Cu	copper	745	1.9	1358	2835	8.96	122
30	Zn	zinc	906	1.7	693	1180.	7.134	120.
31	Ga	gallium	579	1.8	303	2477	5.91	123
32	Ge	germanium	762	2.0	1211	3106	5.3234	120.
33	As	arsenic (gray)	944	2.2	1090.	—	5.75	120.
34	Se	selenium (gray)	941	2.6	494	958	4.809	118
35	Br	bromine	1140.	3.0	266	332	3.1028	117
36	Kr	krypton	1351	—	116	120.	0.003425	116
37	Rb	rubidium	403	0.8	312	961	1.53	215
38	Sr	strontium	549	1.0	1050.	1655	2.64	190.
39	Y	yttrium	600.	1.2	1795	3618	4.47	176
40	Zr	zirconium	640.	1.3	2128	4682	6.52	164

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