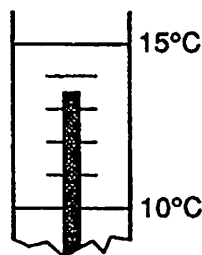1. The diagram below represents a portion of a thermometer that is measuring the temperature of a solution.

According to the thermometer, the temperature of the solution is

(1) 13.50°C   (3) 16.50°C
(2) 13.5°C   (4) 16.5°C

2. A student calculates the density of an unknown solid. The mass is 10.04 grams, and the volume is 8.21 cubic centimeters. How many significant figures should appear in the final answer?

(1) 1   (3) 3
(2) 2   (4) 4

3. During a laboratory experiment, a sample of aluminum is found to have a mass of 12.50 grams and a volume of 4.6 milliliters.

What is the density of this sample, expressed to the correct number of significant figures?

(1) 2.717 g/mL   (3) 3 g/mL
(2) 2.72 g/mL   (4) 2.7 g/mL

4. One kiloJoule is the same as

(1) 0.001 Joule   (3) 100 Joules
(2) 0.01 Joule   (4) 1,000 Joules

5. The measurement 0.41006 gram, rounded to three significant figures, is expressed as

(1) 0.41 g   (3) 0.4100 g
(2) 0.410 g   (4) 0.4101 g

6. Which measurement contains a total of three significant figures?

(1) 0.012 g   (3) 1,205 g
(2) 0.125 g   (4) 12,050g

7. The following weighings were made during a laboratory exercise:

Mass of evaporating dish.....59.260 g
Mass of sugar sample ....1.61 g

What is the total mass of the evaporating dish plus the sample, expressed to the proper number of significant figures?

(1) 60.870 g   (3) 60.9 g
(2) 60.87 g   (4) 61 g

8. Which substance will readily sublime at STP?

(1) Fe(s)   (3) NaCl(s)
(2) $C_6H_{12}O_6(s)$ (4) $CO_2(s)$

9. Which phase change at STP represents sublimation?

(1) $CO_2(s) \rightarrow CO_2(g)$ (3) $CO_2(\ell) \rightarrow CO_2(g)$
(2) $H_2O(s) \rightarrow H_2O(\ell)$ (4) $H_2O(\ell) \rightarrow H_2O(s)$

10. Which statement describes a chemical property of the element magnesium?

(1) Magnesium is malleable.
(2) Magnesium conducts electricity.
(3) Magnesium reacts with an acid.
(4) Magnesium has a high boiling point.

11. A 10.0-gram sample of which element has the *smallest* volume at STP?

(1) aluminum   (3) titanium
(2) magnesium   (4) zinc

12. Which gaseous element has the greatest density at STP?

(1) N_2 (3) Cl_2
(2) O_2 (4) F_2

13. Which statement describes a chemical property of iron?

(1) Iron can be flattened into sheets.
(2) Iron conducts electricity and heat.
(3) Iron combines with oxygen to form rust.
(4) Iron can be drawn into a wire.

14. Matter that is composed of two or more different elements chemically combined in a fixed proportion is classified as

(1) a compound   (3) a mixture
(2) an isotope   (4) a solution
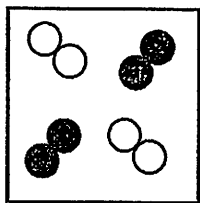
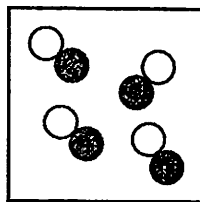15. Which particle diagram represents a sample of one compound, only?

Key
◯ = atom of one element
⬤ = atom of a different element
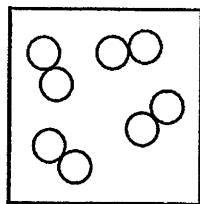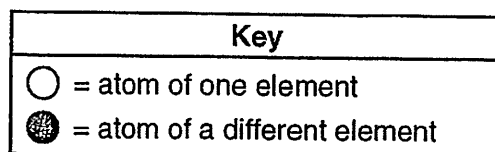
(1)
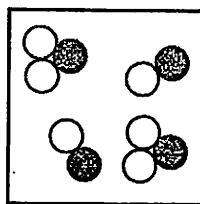
(3)

(2)

(4)

16. Two substances, A and Z, are to be identified. Substance A can *not* be broken down by a chemical change. Substance Z can be broken down by a chemical change. What can be concluded about these substances?
    (1) Both substances are elements.
    (2) Both substances are compounds.
    (3) Substance A is an element and substance Z is a compound.
    (4) Substance A is a compound and substance Z is an element.

17. Which type of change must occur to form a compound?
    (1) chemical   (3) nuclear
    (2) physical   (4) phase

18. Bronze contains 90 to 95 percent copper and 5 to 10 percent tin. Because these percentages can vary, bronze is classified as
    (1) a compound   (3) a mixture
    (2) an element   (4) a substance

19. Which type of bond is found in sodium bromide?
    (1) covalent   (3) ionic
    (2) hydrogen   (4) metallic

20. Which formula represents a homogeneous mixture?
    (1) $H_2O(\ell)$ (3) NaH(s)
    (2) $H_2S(g)$ (4) HCl(aq)

21. Which statement is an identifying characteristic of a mixture?
    (1) A mixture can consist of a single element.
    (2) A mixture can be separated by physical means.
    (3) A mixture must have a definite composition by weight.
    (4) A mixture must be homogeneous.

22. When a mixture of water, sand, and salt is filtered, what passes through the filter paper?
    (1) water, only   (3) water and salt, only
    (2) water and sand, only (4) water, sand, and salt

23. A bottle of rubbing alcohol contains both 2-propanol and water. These liquids can be separated by the process of distillation because the 2-propanol and water
    (1) have combined chemically and retain their different boiling points
    (2) have combined chemically and have the same boiling point
    (3) have combined physically and retain their different boiling points
    (4) have combined physically and have the same boiling point

24. As ice melts at standard pressure, its temperature remains at 0°C until it has completely melted. Its potential energy
    (1) decreases   (3) remains the same
    (2) increases

25. Which kind of energy is stored within a chemical substance?
    (1) free energy   (3) kinetic energy
    (2) activation energy (4) potential energy

26. The temperature of a sample of a substance changes from 10.°C to 20.°C. How many Kelvin does the temperature change?
    (1) 10.   (3) 283
    (2) 20.   (4) 293

27. The temperature 30. K expressed in degrees Celsius is
    (1) 243°C   (3) 303°C
    (2) –243°C   (4) –303°C

28. At which Celsius temperature does lead change from a solid to a liquid?
    (1) 874°C   (3) 328°C
    (2) 601°C   (4) 0°C

29. 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 48 kilopascals?
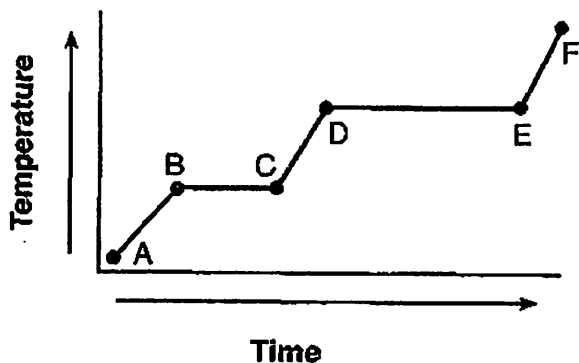   (1) 25°C   (3) 35°C
    (2) 30.°C   (4) 40.°C

30. Which substance has vibrating particles in regular, fixed positions?
    (1) Ca(s)   (3) $Cl_2(g)$
    (2) Hg(ℓ)   (4) $CaCl_2(aq)$

31. Which phase change is exothermic?
    (1) solid to liquid   (3) liquid to solid
   (2) solid to gas   (4) liquid to gas

32. The graph below represents the uniform heating of a substance, starting below its melting point, when the substance is solid.

Time

Which line segments represent an increase in average kinetic energy?
    (1) $\overline{AB}$ and $\overline{BC}$ (3) $\overline{BC}$ and $\overline{DE}$
    (2) $\overline{AB}$ and $\overline{CD}$ (4) $\overline{DE}$ and $\overline{EF}$

33. The graph below represents the uniform heating of a substance, starting with the substance as a solid below its melting point.

Time
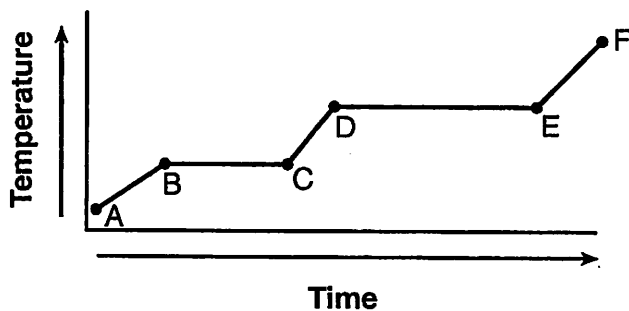
Which line segment represents an increase in potential energy and no change in average kinetic energy?
    (1) $\overline{AB}$ (3) $\overline{CD}$
    (2) $\overline{BC}$ (4) $\overline{EF}$

Base your answers to questions 34 and 35 on the graph below, which represents uniform cooling of a sample of a pure substance, starting as a gas.

Time in Minutes
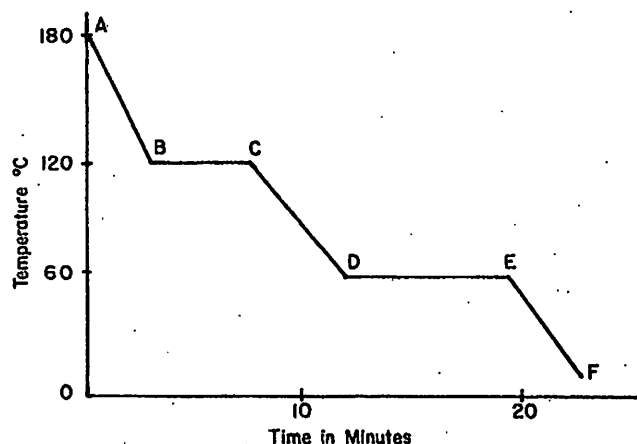
34. Solid and liquid phases can exist in equilibrium between points
    (1) E and F (3) C and D
    (2) B and C (4) D and E

35. The boiling point of the substance is
    (1) 10°C   (3) 120°C
    (2) 60°C   (4) 180°C

36. The temperature of a sample of water changes from 10.°C to 20.°C when the water absorbs 420 Joules of heat. What is the mass of the sample?
    (1) 1.0 g   (3) 100 g
    (2) 10. g   (4) 1000 g

37. An 80.0-gram sample of water at 10.0°C absorbs 1680 Joules of heat energy. What is the final temperature of the water?
    (1) 50.0°C   (3) 5.00°C
   (2) 15.0°C   (4) 4.00°C

38. In an experiment using a calorimeter, the following data were obtained:

    Mass of calorimeter + water . . . . . . .150. g
    Mass of calorimeter. . . . . .100. g
    Final temperature of water. . . . . 55°C
    Initial temperature of water . . . . 25°C

    What is the total number of Joules absorbed by the water?
    (1) 4200   (3) 12600
    (2) 6300   (4) 18900

39. When a 500. gram sample of water at 19.0°C absorbs 8.40 kiloJoules of heat, the temperature of the water will change to

(1) 23.0°C   (3) 15.0°C

(2) 19.0°C   (4) 4.00°C

40. What is the total number of joules released when a 5.00-gram sample of water changes from liquid to solid at 0°C?

(1) 334 J   (3) 2260 J

(2) 1670 J   (4) 11 300 J

41. The heat energy required to change a unit mass of a solid into a liquid at constant temperature is called

(1) heat of vaporization   (3) heat of solution

(2) heat of formation   (4) heat of fusion

42. What is the total number of kiloJoules of heat needed to change 150. grams of ice to water at 0°C?

(1) 50.1   (3) 184

(2) 2.22   (4) 484

43. How much energy is required to vaporize 10.00 grams of water at its boiling point?

(1) 2.26 kJ   (3) 4.2 kJ

(2) 3.34 kJ   (4) 22.6 kJ

44. At 1 atmosphere of pressure, 25.0 grams of a compound at its normal boiling point is converted to a gas by the addition of 34,400 Joules. What is the heat of vaporization for this compound, in Joules per gram?

(1) 25.0 J/g   (3) 2,260 J/g

(2) 1376 J/g   (4) 34,400 J/g

45. Using your knowledge of chemistry and the information in Reference Table *H*, which statement concerning propanone and water at 50°C is true?

(1) Propanone has a higher vapor pressure and stronger intermolecular forces than water.

(2) Propanone has a higher vapor pressure and weaker intermolecular forces than water.

(3) Propanone has a lower vapor pressure and stronger intermolecular forces than water.

(4) Propanone has a lower vapor pressure and weaker intermolecular forces than water.

46. As the temperature of a liquid increases, its vapor pressure

(1) decreases   (3) remains the same

(2) increases

47. A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?

(1) The number of gas molecules increases.

(2) The number of collisions between gas molecules per unit time decreases.

(3) The average velocity of the gas molecules increases.

(4) The volume of the gas decreases.

48. Under which conditions of temperature and pressure would helium behave most like an ideal gas?

(1) 50 K and 20 kPa   (3) 750 K and 20 kPa

(2) 50 K and 600 kPa   (4) 750 K and 600 kPa

49. 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

50. A real gas differs from an ideal gas because the molecules of real gas have

(1) some volume and no attraction for each other

(2) some volume and some attraction for each other

(3) no volume and no attraction for each other

(4) no volume and some attraction for each other

51. At the same temperature and pressure, 1.0 liter of $CO(g)$ and 1.0 liter of $CO_2(g)$ have

(1) equal masses and the same number of molecules

(2) different masses and a different number of molecules

(3) equal volumes and the same number of molecules

(4) different volumes and a different number of molecules

52. A sample of helium gas has a volume of 900. milliliters and a pressure of 2.50 atm at 298 K. What is the new pressure when the temperature is changed to 336 K and the volume is decreased to 450. milliliters?

(1) 0.177 atm   (3) 5.64 atm

(2) 4.43 atm   (4) 14.1 atm

53. Which graph best represents the pressure-volume relationship for an ideal gas at constant temperature?
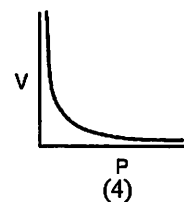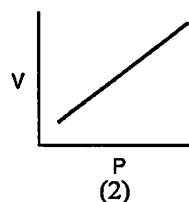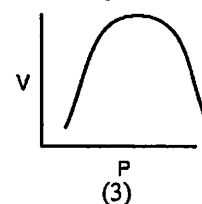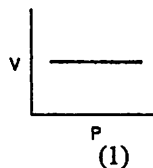
54. A gas occupies a volume of 40.0 milliliters at 20°C. If the volume is increased to 80.0 milliliters at constant pressure, the resulting temperature will be equal to

$$20°C \times \frac{80.0mL}{40.0mL}$$
(1)

$$293K \times \frac{80.0mL}{40.0mL}$$
(3)

$$20°C \times \frac{40.0mL}{80.0mL}$$
(2)

$$293K \times \frac{40.0mL}{80.0mL}$$
(4)

55. As the temperature of a gas increases at constant pressure, the volume of the gas

(1) decreases
(2) increases
(3) remains the same

56. A cylinder with a tightly fitted piston is shown in the diagram below.

Air at constant temperature
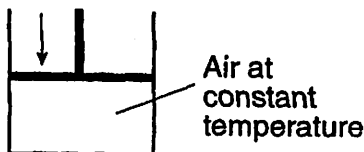
As the piston moves downward, the number of molecules of air in the cylinder

(1) decreases
(2) increases
(3) remains the same

57. If 60. liters of hydrogen gas at 546 K is cooled to 273 K at constant pressure, the new volume of the gas will be

(1) 120 L
(2) 20. L
(3) 30. L
(4) 40. L

58. Which changes in pressure and temperature occur as a given mass of gas at 50.6 kPa and 546 K is changed to STP?

(1) The pressure is doubled and the temperature is halved.
(2) The pressure is halved and the temperature is doubled.
(3) Both the pressure and the temperature are doubled.
(4) Both the pressure and the temperature are halved.

59. The volume of a 1.00-mole sample of an ideal gas will decrease when the

(1) pressure decreases and the temperature decreases
(2) pressure decreases and the temperature increases
(3) pressure increases and the temperature decreases
(4) pressure increases and the temperature increases

60. 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

61. The light produced by signs using neon gas results from electrons that are

(1) moving from a higher to a lower principal energy level
(2) moving from a lower to a higher principal energy level
(3) being lost by the Ne(g) atoms
(4) being gained by the Ne(g) atoms

62. 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

63. Which statement best describes the nucleus of an aluminum atom?

(1) It has a charge of +13 and is surrounded by a total of 10 electrons.
(2) It has a charge of +13 and is surrounded by a total of 13 electrons.
(3) It has a charge of -13 and is surrounded by a total of 10 electrons.
(4) It has a charge of -13 and is surrounded by a total of 13 electrons.

64. In which group do the particles contain only nucleons?

(1) protons and electrons
(2) neutrons and electrons
(3) protons and neutrons
(4) protons, neutrons, and electrons

65. What is the charge and mass of a proton?

(1) charge of +1 and mass of 1 amu
(2) charge of +1 and mass of $\frac{1}{1836}$ amu
(3) charge of -1 and mass of 1 amu
(4) charge of -1 and mass of $\frac{1}{1836}$ amu

66. As the number of neutrons in the nucleus of an atom increases, the nuclear charge of the atom

(1) decreases
(2) increases
(3) remains the same

67. 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.

68. Compared to the entire atom, the nucleus of the atom is
    (1) smaller and contains most of the atom's mass
    (2) smaller and contains little of the atom's mass
    (3) larger and contains most of the atom's mass
    (4) larger and contains little of the atom's mass

69. What is the net charge on an ion that has 9 protons, 11 neutrons, and 10 electrons?
    (1) 1+   (3) 1–
    (2) 2+   (4) 2–

70. Compared to an atom of phosphorus-31, an atom of sulfur-32 contains
    (1) one less neutron   (3) one more neutron
    (2) one less proton   (4) one more proton

71. How many electrons are in an Fe^{2+} ion
    (1) 24   (3) 28
    (2) 26   (4) 56

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

73. An ion with 5 protons, 6 neutrons, and a charge of 3^+ has an atomic number of
    (1) 5   (3) 8
    (2) 6   (4) 11

74. An atom of helium-4 differs from an atom of lithium-7 in that the atom of helium-4 has
    (1) one more proton   (3) two less protons
    (2) one more neutron   (4) two less neutrons

75. The atomic mass unit is defined as exactly 1/12 the mass of an atom of
    (1) $^{12}_{6}C$
    (2) $^{14}_{6}C$
    (3) $^{24}_{12}Mg$
    (4) $^{26}_{12}Mg$

76. Atoms of different isotopes of the same element differ in their total number of
    (1) electrons   (3) protons
    (2) neutrons   (4) valence electrons

77. The nucleus of an atom of cobalt-58 contains
    (1) 27 protons and 31 neutrons
    (2) 27 protons and 32 neutrons
    (3) 59 protons and 60 neutrons
    (4) 60 protons and 60 neutrons

78. Atoms of ^{16}O, ^{17}O, and ^{18}O have the same number of
    (1) neutrons, but a different number of protons
    (2) protons, but a different number of neutrons
    (3) protons, but a different number of electrons
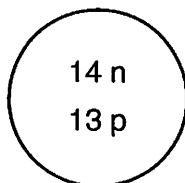   (4) electrons, but a different number of protons

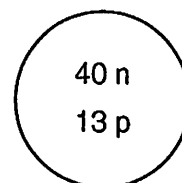79. Which diagram represents the nucleus of an atom of $^{27}_{13}Al$?

14 n
27 p
(1)

27 n
13 p
(3)

14 n
13 p
(2)
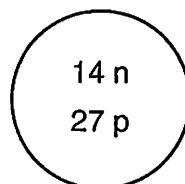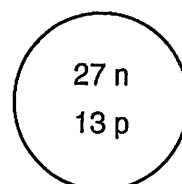
40 n
13 p
(4)

80. The nucleus of which atom contains 48 neutrons?
    (1) $^{32}_{16}S$
    (2) $^{48}_{22}Ti$
    (3) $^{85}_{37}Rb$
    (4) $^{112}_{48}Cd$

81. Which atoms are isotopes of the same element?
    (1) $^{24}_{12}X$ and $^{25}_{12}X$
    (2) $^{20}_{10}X$ and $^{20}_{11}X$
    (3) $^{31}_{15}X$ and $^{32}_{16}X$
    (4) $^{31}_{19}X$ and $^{31}_{19}X$

82. The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are closest to
    (1) 31% A-63 and 69% A-65 (3) 69% A-63 and 31% A-65
    (2) 50% A-63 and 50% A-65 (4) 100% A-63 and 0% A-65

83. The atomic mass of an element is calculated using the
    (1) atomic number and the ratios of its naturally occurring isotopes
    (2) atomic number and the half-lives of each of its isotopes
    (3) masses and the ratios of its naturally occurring isotopes
    (4) masses and the half-lives of each of its isotopes

84. A sample of element X contains 90. percent ^{35}X atoms, 8.0 percent ^{37}X atoms, and 2.0 percent ^{38}X atoms. The average isotopic mass is closest to
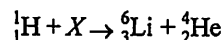   (1) 32   (3) 37
    (2) 35   (4) 38

85. In a 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

86. The modern model of the atom shows that electrons are
(1) orbiting the nucleus in fixed paths
(2) found in regions called orbitals
(3) combined with neutrons in the nucleus
(4) located in a solid sphere covering the nucleus

87. How many electrons are in the outermost principal energy level (shell) of an atom of carbon in the ground state?
(1) 6
(2) 2
(3) 3
(4) 4

88. Which atom in the ground state has five electrons in its outer level and ten electrons in its kernel?
(1) C
(2) Cl
(3) Si
(4) P

89. Which electron configuration represents an atom of an element having a completed third principal energy level?
(1) 2-8-2
(2) 2-8-6-2
(3) 2-8-10-2
(4) 2-8-18-2

90. Which element has atoms with only one completely filled principal energy level?
(1) N
(2) P
(3) As
(4) Sb

91. Which electron configuration could represent a strontium atom in an excited state?
(1) 2–8–18–7–1
(2) 2–8–18–7–3
(3) 2–8–18–8–1
(4) 2–8–18–8–2

92. As an electron in an atom moves from the ground state to the excited state, the electron
(1) gains energy as it moves to a higher energy level
(2) gains energy as it moves to a lower energy level
(3) loses energy as it moves to a higher energy level
(4) loses energy as it moves to a lower energy level

93. What is the electron configuration for Be^{2+} ions?
(1) 1
(2) 2
(3) 2-1
(4) 2-2

94. Which Lewis electron-dot diagram represents a boron atom in the ground state?

$\cdot B$
(1)

$:\overset{\cdot}{B}\cdot$
(3)

$:\overset{\cdot}{B}$
(2)

$:\overset{\cdot}{\underset{\cdot}{B}}\cdot$
(4)

95. Given the nuclear equation:

$$_1^1H + X \rightarrow {}_3^6Li + {}_2^4He$$

The particle represented by X is
(1) $_4^9Li$
(2) $_4^9Be$
(3) $_5^{10}Be$
(4) $_6^{10}C$

96. Which reaction is an example of natural transmutation?
(1) $_{94}^{239}Pu \rightarrow {}_{92}^{235}U + {}_2^4He$
(2) $_{13}^{27}Al + {}_2^4He \rightarrow {}_{15}^{30}P + {}_0^1n$
(3) $_{92}^{238}U + {}_0^1n \rightarrow {}_{94}^{239}Pu + 2{}_{-1}^0e$
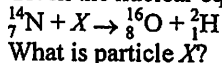(4) $_{94}^{239}Pu + {}_0^1n \rightarrow {}_{56}^{147}Ba + {}_{38}^{90}Sr + 3{}_0^1n$

97. Which of these types of nuclear radiation has the greatest penetrating power?
(1) alpha
(2) beta
(3) neutron
(4) gamma

98. Alpha particles are emitted during the radioactive decay of
(1) carbon-14
(2) neon-19
(3) calcium-37
(4) radon-222

99. Given the nuclear equation:
$_7^{14}N + X \rightarrow {}_8^{16}O + {}_1^2H$
What is particle X?
(1) an alpha particle
(2) a beta particle
(3) a deuteron
(4) a triton

100. Which equation represents positron decay?
(1) $_{37}^{87}Rb \rightarrow {}_{-1}^0e + {}_{38}^{87}Sr$
(2) $_{92}^{277}U \rightarrow {}_{90}^{223}Th + {}_2^4He$
(3) $_{13}^{27}Al + {}_2^4He \rightarrow {}_{15}^{30}P + {}_0^1n$
(4) $_6^{11}C \rightarrow {}_{+1}^0e + {}_5^{11}B$

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

102. The diagram below represents radiation passing through an electric field.
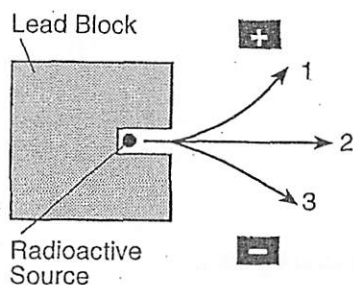
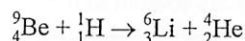Which type of emanation is represented by the arrow labeled 2?

(1) alpha particle   (3) positron

(2) beta particle   (4) gamma radiation

103. If $\frac{1}{8}$ 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   (3) 34.5 min

(2) 23.0 min   (4) 46.0 min

104. Based on Reference Table N, what fraction of a radioactive ^{90}Sr sample would remain unchanged after 56.2 years?

(1) $\frac{1}{2}$

(2) $\frac{1}{4}$

(3) $\frac{1}{8}$

(4) $\frac{1}{16}$

105. How many days are required for 200. grams of radon-222 to decay to 50.0 grams?

(1) 1.91 days   (3) 7.64 days

(2) 3.82 days   (4) 11.5 days

106. As a sample of the radioactive isotope ^{131}I decays, its half-life

(1) decreases   (3) remains the same

(2) increases

107. What was the original mass of a radioactive sample that decayed to 25 grams in four half-life periods?

(1) 50 g   (3) 200 g

(2) 100 g   (4) 400 g

108. Given the nuclear reaction:

$$^{32}_{16}S + ^{1}_{0}n \rightarrow ^{1}_{1}H + X$$
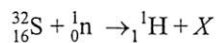
What does X represent in this reaction?

(1) $^{31}_{15}P$

(2) $^{32}_{15}P$

(3) $^{31}_{16}P$

(4) $^{32}_{16}P$

109. Given the reaction:

$$^{9}_{4}Be + ^{1}_{1}H \rightarrow ^{6}_{3}Li + ^{4}_{2}He$$

Which type of reaction is represented?

(1) natural transmutation   (3) fission

(2) artificial transmutation   (4) fusion

110. A particle accelerator is used to provide charged particles with sufficient

(1) kinetic energy to penetrate a nucleus

(2) kinetic energy to penetrate an electron cloud

(3) potential energy to penetrate a nucleus

(4) potential energy to penetrate an electron cloud

111. Which statement best describes what happens in a fission reaction?

(1) Heavy nuclei split into lighter nuclei.

(2) Light nuclei form into heavier nuclei.

(3) Energy is released and less stable elements are formed.

(4) Energy is absorbed and more stable elements are formed.

112. The diagram below represents a nuclear reaction in which a neutron bombards a heavy nucleus.
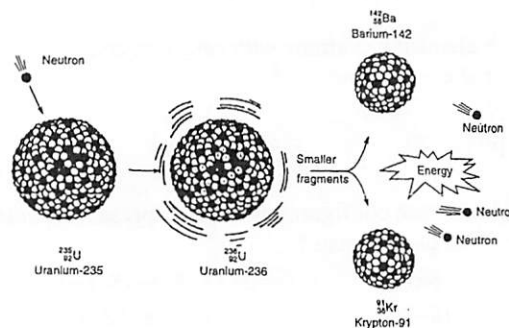
Which type of reaction does the diagram illustrate?

(1) fission   (3) alpha decay

(2) fusion   (4) beta decay

113. Which equation represents a fusion reaction?

(1) $H_2O(g) \rightarrow H_2O(\ell)$

(2) $C(s) + O_2(g) \rightarrow CO_2(g)$

(3) $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$

(4) $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3^{1}_{0}n$

114. High energy is a requirement for fusion reactions to occur because the nuclei involved

(1) attract each other because they have like charges

(2) attract each other because they have unlike charges

(3) repel each other because they have like charges

(4) repel each other because they have unlike charges

115. In a nuclear fusion reaction, the mass of the products is
   (1) less than the mass of the reactants because some of the mass has been converted to energy
   (2) less than the mass of the reactants because some of the energy has been converted to mass
   (3) more than the mass of the reactants because some of the mass has been converted to energy
   (4) more than the mass of the reactants because some of the energy has been converted to mass

116. Which statement explains why nuclear waste materials may pose a problem?
   (1) They frequently have short half-lives and remain radioactive for brief periods of time.
   (2) They frequently have short half-lives and remain radioactive for extended periods of time.
   (3) They frequently have long half-lives and remain radioactive for brief periods of time.
   (4) They frequently have long half-lives and remain radioactive for extended periods of time.

117. The decay of which radioisotope 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

118. Which radioisotope is used in medicine to treat thyroid disorders?
   (1) cobalt-60
   (2) iodine-131
   (3) phosphorus-32
   (4) uranium-238

119. Radioisotopes used for medical diagnosis must have
   (1) long half-lives and be quickly eliminated by the body
   (2) long half-lives and be slowly eliminated by the body
   (3) short half-lives and be quickly eliminated by the body
   (4) short half-lives and be slowly eliminated by the body

120. What is the correct name of Fe_2O_3?
   (1) iron (I) oxide
   (2) iron (II) oxide
   (3) iron (III) oxide
   (4) iron (V) oxide

121. What is the correct name of the compound with the formula NH_4NO_2?
   (1) ammonia nitrite
   (2) ammonium nitrite
   (3) ammonia nitrate
   (4) ammonium nitrate

122. What is the correct name for the compound with the formula $CrPO_4$?
   (1) chromium (II) phosphate
   (2) chromium (III) phosphate
   (3) chromium (II) phosphide
   (4) chromium (III) phosphide

123. What is the name for $NaClO_3$?
   (1) sodium chlorite
   (2) sodium chloride
   (3) sodium chlorate
   (4) sodium perchlorate

124. What is the chemical formula for sodium sulfate?
   (1) Na_2SO_3
   (2) Na_2SO_4
   (3) $NaSO_3$
   (4) $NaSO_4$

125. What is the chemical formula for copper(II) hydroxide?
   (1) $CuOH$
   (2) $CuOH_2$
   (3) $Cu_2(OH)$
   (4) $Cu(OH)_2$

126. If M represents an element in Group 2, the formula of its chloride would be
   (1) MCl
   (2) MCl_2
   (3) M_2Cl
   (4) M_2Cl_2

127. What is conserved during a chemical reaction?
   (1) energy, only
   (2) matter, only
   (3) both matter and energy
   (4) neither matter nor energy

128. Which equation illustrates conservation of mass?
   (1) $H_2 + Cl_2 \rightarrow HCl$
   (2) $H_2 + Cl_2 \rightarrow 2\,HCl$
   (3) $H_2 + O_2 \rightarrow H_2O$
   (4) $H_2 + O_2 \rightarrow 2\,H_2O$

129. Given the unbalanced equation:

   $$\_\_Mg(ClO_3)_2(s) \rightarrow \_\_MgCl_2(s) + \_\_O_2(g)$$
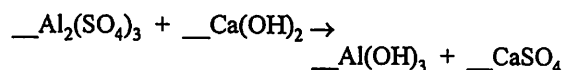
   What is the coefficient of O_2 when the equation is balanced correctly using the *smallest* whole number coefficients?
   (1) 1
   (2) 2
   (3) 3
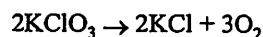   (4) 4

130. Given the unbalanced equation:

   $$\_\_Al_2(SO_4)_3 + \_\_Ca(OH)_2 \rightarrow$$
   $$\_\_Al(OH)_3 + \_\_CaSO_4$$

   When the equation is completely balanced using the smallest whole number coefficients the sum of the coefficients is
   (1) 5
   (2) 9
   (3) 3
   (4) 4

131. Given the balanced equation:

   $$2KClO_3 \rightarrow 2KCl + 3O_2$$

   Which type of reaction is represented by this equation?
   (1) synthesis
   (2) decomposition
   (3) single replacement
   (4) double replacement

132. Which equation represents a double replacement reaction?
   (1) $2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$
   (2) $CaCO_3 \rightarrow CaO + CO_2$
   (3) $LiOH + HCl \rightarrow LiCl + H_2O$
   (4) $CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$

133. Which two characteristics are associated with metals?
    (1) low first ionization energy and low electronegativity
    (2) low first ionization energy and high electronegativity
    (3) high first ionization energy and low electronegativity
    (4) high first ionization energy and high electronegativity

134. Which element is malleable and can conduct electricity in the solid phase?
    (1) iodine
    (3) sulfur
    (2) phosphorus
    (4) tin

135. The elements located in the lower left corner of the Periodic Table are classified as
    (1) metals
    (3) metalloids
    (2) nonmetals
    (4) noble gases

136. Which of the following Group 15 elements has the greatest metallic character?
    (1) nitrogen
    (3) antimony
    (2) phosphorus
    (4) bismuth

137. Which element is malleable and ductile?
    (1) S
    (3) Ge
    (2) Si
    (4) Au

138. In which section of the Periodic Table are the most active metals located?
    (1) upper right corner
    (3) upper left corner
    (2) lower right corner
    (4) lower left corner

139. Atoms of metallic elements tend to
    (1) gain electrons and form negative ions
    (2) gain electrons and form positive ions
    (3) lose electrons and form negative ions
    (4) lose electrons and form positive ions

140. 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
    (3) 16
    (2) 13
    (4) 17

141. What are two properties of most nonmetals?
    (1) high ionization energy and poor electrical conductivity
    (2) high ionization energy and good electrical conductivity
    (3) low ionization energy and poor electrical conductivity
    (4) low ionization energy and good electrical conductivity

142. Which isotopic notation identifies a metalloid that is matched with the corresponding number of protons in each of its atoms?
    (1) ^{24}Mg and 12 protons
    (2) ^{28}Si and 14 protons
    (3) ^{75}As and 75 protons
    (4) ^{80}Br and 80 protons

143. Which pair of symbols represents a metalloid and a noble gas?
    (1) Si and Bi
    (3) Ge and Te
    (2) As and Ar
    (4) Ne and Xe

144. At standard pressure, which element has a melting point higher than standard temperature?
    (1) F_2
    (3) Fe
    (2) Br_2
    (4) Hg

145. Which isotope is radioactive?
    (1) C–12
    (3) Tc–99
    (2) Ne–20
    (4) Pb–206

146. Which Group 16 element has only unstable isotopes?
    (1) Po
    (3) Se
    (2) Te
    (4) S

147. Which group contains elements in three phases of matter at STP?
    (1) Group 2
    (3) Group 15
    (2) Group 6
    (4) Group 17

148. The elements on the Periodic Table are arranged in order of increasing
    (1) boiling point
    (3) atomic number
    (2) electronegativity
    (4) atomic mass

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

150. 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.

151. Which list of elements is arranged in order of increasing atomic radii?
    (1) Li, Be, B, C
    (3) Sc, Ti, V, Cr
    (2) Sr, Ca, Mg, Be
    (4) F, Cl, Br, I

152. Which of the following electron configurations represents the element with the smallest atomic radius?
    (1) 2-4
    (3) 2-6
    (2) 2-5
    (4) 2-7

153. The strength of an atom's attraction for the electrons in a chemical bond is the atom's
    (1) electronegativity
    (3) heat of reaction
    (2) ionization energy
    (4) heat of formation

154. Based on Reference Table S, which of the following atoms requires the *least* energy for the removal of the most loosely bound electron?
    (1) Sn
    (3) Be
    (2) Sr
    (4) Br

155. Which Group 15 element exists as a diatomic molecule at STP?
    (1) phosphorus
    (3) bismuth
    (2) nitrogen
    (4) arsenic

156. Alkali metals, alkaline earth metals, and halogens are elements found respectively in Groups
    (1) 1, 2, and 18
    (3) 1, 2, and 14
    (2) 2, 13, and 17
    (4) 1, 2, and 17

157. 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 increases, and the first ionization energy generally decreases.

158. As the elements in Period 2 of the Periodic Table are considered in succession from left to right, there is a decrease in atomic radius with increasing atomic number. This may best be explained by the fact that the
    (1) number of protons increases, and the number of shells of electrons remains the same
    (2) number of protons increases, and the number of shells of electrons increases
    (3) number of protons decreases, and the number of shells of electrons remains the same
    (4) number of protons decreases, and the number of shells of electrons increases

159. What occurs as the atomic number of the elements in Period 2 increases?
    (1) The nuclear charge of each successive atom decreases, and the atomic radius decreases.
    (2) The nuclear charge of each successive atom decreases, and the atomic radius increases.
    (3) The nuclear charge of each successive atom increases, and the atomic radius decreases.
    (4) The nuclear charge of each successive atom increases, and the atomic radius increases.

160. Compared to an atom of potassium, an atom of calcium has a
    (1) larger radius and lower reactivity
    (2) larger radius and higher reactivity
    (3) smaller radius and lower reactivity
    (4) smaller radius and higher reactivity

161. Which group on the Periodic Table of the Elements contains elements that react with oxygen to form compounds with the general formula X_2O?
    (1) Group 1
    (3) Group 14
    (2) Group 2
    (4) Group 18

162. As the elements in Group 15 are considered in order of increasing atomic number, which sequence in properties occurs?
    (1) nonmetal → metalloid → metal
    (2) metalloid → metal → nonmetal
    (3) metal → metalloid → nonmetal
    (4) metal → nonmetal → metalloid

163. Which of the following Period 3 elements has the *least* metallic character?
    (1) Na
    (3) Al
    (2) Mg
    (4) Si

164. The carbon atoms in graphite and the carbon atoms in diamond have different
    (1) atomic numbers
    (3) electronegativities
    (2) atomic masses
    (4) structural arrangements

165. At STP, the element oxygen can exist as either O_2 or O_3 gas molecules. These two forms of the element have
    (1) the same chemical and physical properties
    (2) the same chemical properties and different physical properties
    (3) different chemical properties and the same physical properties
    (4) different chemical and physical properties

166. Which statement best describes Group 2 elements as they are considered in order from top to bottom of the Periodic Table?
    (1) The number of principal energy levels increases, and the number of valence electrons increases.
    (2) The number of principal energy levels increases, and the number of valence electrons remains the same.
    (3) The number of principal energy levels remains the same, and the number of valence electrons increases.
    (4) The number of principal energy levels remains the same, and the number of valence electrons decreases.

167. Atoms of elements in a group on the Periodic Table have similar chemical properties. This similarity is most closely related to the atoms'

(1) number of principal energy levels (shells)
(2) number of valence electrons
(3) atomic numbers
(4) atomic masses

168. Compared to the valence electrons of a nonmetallic atom, the valence electrons of a metallic atom are generally

(1) fewer in number and less strongly held
(2) fewer in number and more strongly held
(3) greater in number and less strongly held
(4) greater in number and more strongly held

169. Compared to a phosphorus atom, a P^{3-} ion has

(1) more electrons and a larger radius
(2) more electrons and a smaller radius
(3) fewer electrons and a larger radius
(4) fewer electrons and a smaller radius

170. Which ionic compound dissolves in water to form a colored solution?

(1) $Ca(NO_3)_2$ (3) KNO_3
(2) $Cu(NO_3)_2$ (4) $Al(NO_3)_3$

171. Which grouping of circles, when considered in order from the top to the bottom, best represents the relative size of the atoms of Li, Na, K, and Rb, respectively?

(1)

(3)

(2)

(4)
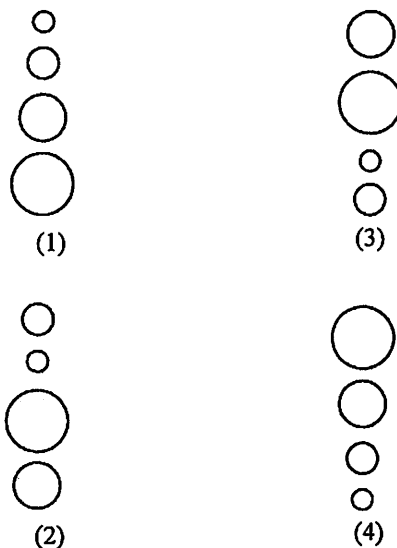
#	Ans	#	Ans	#	Ans	#	Ans	#	Ans	#	Ans
1.	2	30.	1	59.	3	88.	4	117.	4	146.	1
2.	3	31.	3	60.	1	89.	4	118.	2	147.	4
3.	4	32.	2	61.	1	90.	1	119.	3	148.	3
4.	4	33.	2	62.	2	91.	2	120.	3	149.	2
5.	2	34.	4	63.	2	92.	1	121.	2	150.	4
6.	2	35.	3	64.	3	93.	2	122.	2	151.	4
7.	2	36.	2	65.	1	94.	2	123.	3	152.	4
8.	4	37.	2	66.	3	95.	2	124.	2	153.	1
9.	1	38.	2	67.	1	96.	1	125.	4	154.	2
10.	3	39.	1	68.	1	97.	4	126.	2	155.	2
11.	4	40.	2	69.	3	98.	4	127.	3	156.	4
12.	3	41.	4	70.	4	99.	1	128.	2	157.	1
13.	3	42.	1	71.	1	100.	4	129.	3	158.	1
14.	1	43.	4	72.	3	101.	4	130.	2	159.	3
15.	4	44.	2	73.	1	102.	4	131.	2	160.	3
16.	3	45.	2	74.	4	103.	1	132.	3	161.	1
17.	1	46.	2	75.	1	104.	2	133.	1	162.	1
18.	3	47.	3	76.	2	105.	3	134.	4	163.	4
19.	3	48.	3	77.	1	106.	3	135.	1	164.	4
20.	4	49.	1	78.	2	107.	4	136.	4	165.	4
21.	2	50.	2	79.	2	108.	2	137.	4	166.	2
22.	3	51.	3	80.	3	109.	2	138.	4	167.	2
23.	3	52.	3	81.	1	110.	1	139.	4	168.	1
24.	2	53.	4	82.	3	111.	1	140.	3	169.	1
25.	4	54.	3	83.	3	112.	1	141.	1	170.	2
26.	1	55.	2	84.	2	113.	3	142.	2	171.	1
27.	2	56.	3	85.	1	114.	3	143.	2		
28.	3	57.	3	86.	2	115.	1	144.	3		
29.	3	58.	1	87.	4	116.	4	145.	3		