

- Which of these is a chemical property?  
[A] Sodium is a soft, shiny metal.      [B] Water has a high specific heat.  
[C] Ice melts at 0°C.      [D] Helium is very nonreactive.      [E] Oxygen is a gas.
- Which of the following involves no chemical change?  
[A] lighting a match      [B] driving a car      [C] burning paper  
[D] boiling water      [E] baking a cake
- Which would be an example of a homogeneous mixture?  
[A] soil (dust)    [B] sodium chloride    [C] oily water    [D] aluminum    [E] milk
- Helium is an example of  
[A] a heterogeneous mixture      [B] a homogeneous mixture  
[C] a compound      [D] an element
- A solution can be a heterogeneous or a homogeneous mixture.  
[A] True      [B] False
- The symbol for the element cobalt is  
[A] Cb      [B] K      [C] Cu      [D] C      [E] Co
- How many hydrogen atoms are indicated in the formula  $(\text{NH}_4)_2 \text{C}_8\text{H}_4\text{O}_2$ ?  
[A] 20      [B] 8      [C] 24      [D] 12      [E] none of these
- The fundamental “particle” of a chemical element according to Dalton’s theory is the  
[A] atom      [B] electron      [C] molecule      [D] compound
- The first scientist to show that atoms emit tiny negative particles was  
[A] James Chadwick      [B] J. J. Thomson      [C] Ernest Rutherford  
[D] Lord Kelvin      [E] William Thomson
- The scientist whose alpha-particle scattering experiment led him to conclude that the nucleus of an atom contains a dense center of positive charge is  
[A] William Thomson      [B] J. J. Thomson      [C] Ernest Rutherford  
[D] James Chadwick      [E] Lord Kelvin

11. Which atomic particle determines the chemical behavior of an atom?  
[A] nucleus [B] proton [C] electron [D] neutron [E] none of these
12. An element's most stable ion forms an ionic compound with chlorine having the formula  $\text{XCl}_2$ . If the ion of element X has a mass of 89 and 36 electrons, what is the identity of the element, and how many neutrons does it have?  
[A] Rb, 52 neutrons [B] Se, 55 neutrons [C] Kr, 55 neutrons  
[D] Sr, 51 neutrons [E] Kr, 53 neutrons
13. Atoms of the same element having the same atomic number but different mass numbers are called  
[A] orbitals [B] isomers [C] neutrons [D] nuclei [E] isotopes
14. The mass number of an atom equals  
[A] the atomic number of the element  
[B] the number of protons plus the number of neutrons per atom  
[C] the number of neutrons per atom  
[D] the atomic mass of the element [E] none of these
15. How many neutrons are contained in an iodine nucleus with a mass number of 131?  
[A] 78 [B] 131 [C] 127 [D] 53 [E] 74
16. The number of protons in  $^{200}_{80}\text{Hg}$  is  
[A] 200 [B] 120 [C] dependent on ionic charge [D] 80 [E] unknown
17. The name for  $\text{Hg}_2^{2+}$  is  
[A] mercury(I) ion [B] mercury ion [C] hydrogen ion  
[D] hydrogen(II) ion [E] mercury(II) ion
18. The symbol for the calcium ion is  
[A]  $\text{Ca}^+$  [B]  $\text{C}^{2+}$  [C]  $\text{Ca}^{2+}$  [D]  $\text{Cl}^{2+}$  [E] Ca
19. Titanium(IV) oxide has the formula  
[A]  $\text{Ti}_4\text{O}_2$  [B]  $\text{Ti(IV)O}$  [C]  $\text{TiO}_2$  [D]  $\text{Ti}_4\text{O}$  [E]  $\text{TiO}_4$

20. The binary compound  $\text{PCl}_3$  is called  
[A] triphosphorus chloride [B] phosphorus chloride  
[C] monophosphorus trichloride [D] phosphorus trichloride  
[E] none of these
21. Sodium chlorite has the formula  
[A]  $\text{NaClO}_4$  [B]  $\text{NaCl}$  [C]  $\text{NaClO}_3$  [D]  $\text{NaClO}$  [E]  $\text{NaClO}_2$
22. The formula for the compound formed from ammonium and sulfate ions is  
[A]  $\text{NH}_4(\text{SO}_4)_2$  [B]  $(\text{NH}_4)_2\text{SO}_4$  [C]  $(\text{NH}_4)_3\text{SO}_4$   
[D]  $\text{NH}_4\text{SO}_4$  [E] none of these
23. Express 506100 in scientific notation.  
[A]  $5.1 \times 10^5$  [B]  $5.061 \times 10^5$  [C]  $51 \times 10^5$  [D]  $5.06100 \times 10^5$  [E]  $5 \times 10^5$
24. The number 0.00231 expressed in exponential notation is  
[A]  $2.31 \times 10^3$  [B]  $231 \times 10^3$  [C]  $2.31 \times 10^{-2}$   
[D]  $2.31 \times 10^{-3}$  [E]  $2.31 \times 10^2$
25. The number of milligrams in 100 g is  
[A]  $10^3$  mg [B]  $10^{-6}$  mg [C]  $10^{-5}$  mg [D]  $10^{-3}$  mg [E]  $10^6$  mg
26. The number of cubic centimeters ( $\text{cm}^3$ ) in 43.0 mL is  
[A]  $4.30 \text{ cm}^3$  [B]  $43.0 \text{ cm}^3$  [C]  $0.0430 \text{ cm}^3$  [D] none of these
27. How many significant figures are in the number  $6.022 \times 10^{32}$ ?  
[A] 23 [B] 1 [C] 27 [D] 4 [E] 3
28. A student finds that the weight of an empty beaker is 12.024 g. She places a solid in the beaker to give a combined mass of 12.108 g. To how many significant figures is the mass of the solid known?  
[A] 4 [B] 5 [C] 1 [D] 3 [E] 2

29. Convert 561097 mm to kilometers.  
[A] 561.097 km                      [B] 5610.97 km                      [C] 5.61097 km  
[D]  $5.61097 \times 10^{11}$  km                      [E] 0.561097 km
30. Convert:  $23^{\circ}\text{C} =$  \_\_\_\_\_ K.
31. An experiment requires 75.0 mL of ethyl alcohol. If the density of ethyl alcohol is  $0.790 \text{ g/cm}^3$ , what is the mass of 75.0 mL of ethyl alcohol?
32. What is the mass of one atom of copper in grams?  
[A] 52.0 g    [B] 65.4 g    [C]  $1.06 \times 10^{-22}$  g    [D] 58.9 g    [E] 63.5 g
33. One atom of calcium weighs  
[A] 20 g    [B] 20 amu    [C]  $6.02 \times 10^{23}$  amu    [D] 40.08 g    [E] none of these
34. What is the molar mass of  $\text{K}_2\text{SO}_4$ ?  
[A] 135.16 g/mol                      [B] 87.13 g/mol                      [C] 174.26 g/mol  
[D] 86 g/mol                      [E]  $174 \times 10^{23}$  g/mol
35. Calculate the percentage composition (by mass) of all the elements in  $\text{Cd}_3(\text{AsO}_4)_2$ .
36. The mass percent of oxygen in CaO is  
[A] 25.0%    [B] 50%    [C] cannot be determined from the information given  
[D] 28.5%    [E] 72.4%
37. Which of the following has the empirical formula  $\text{CH}_2$ ?  
[A]  $\text{C}_2\text{H}_4\text{O}$     [B]  $\text{C}_6\text{H}_6$     [C]  $\text{C}_6\text{H}_{12}$     [D]  $\text{H}_2\text{CO}_3$     [E]  $\text{C}_2\text{H}_6$
38. Balance the equation  
 $\text{C}_6\text{H}_{14} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
39. Balance the equation  
 $\text{As}_2\text{O}_3(s) + \text{Ca}(\text{OH})_2(aq) \rightarrow \text{Ca}_3(\text{AsO}_4)_2(s) + \text{H}_2\text{O}(l)$

40. Balance the equation  
 $\text{Sb}(s) + \text{O}_2(g) \rightarrow \text{Sb}_2\text{O}_3(s)$
41. Balance the equation  
 $\text{KClO}_3(s) \rightarrow \text{KCl}(s) + \text{O}_2(g)$
42. The reaction  $\text{AgNO}_3(aq) + \text{NaCl}(aq) \rightarrow \text{AgCl}(s) + \text{NaNO}_3(aq)$  is a(n) \_\_\_\_\_ reaction.  
[A] oxidation-reduction      [B] precipitation      [C] none of these  
[D] acid-base      [E] single-replacement
43. Refer to the following equation:  
 $4\text{NH}_3(g) + 7\text{O}_2(g) \rightarrow 4\text{NO}_2(g) + 6\text{H}_2\text{O}(g)$   
How many molecules of water are produced for each mole of  $\text{NO}_2$  given off?  
[A] 18      [B]  $12.044 \times 10^{23}$       [C]  $9.033 \times 10^{23}$   
[D]  $6.022 \times 10^{23}$       [E] none of these
44. Refer to the following unbalanced equation:  
 $\text{C}_6\text{H}_{14} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$   
What mass of oxygen ( $\text{O}_2$ ) is required to react completely with 25.0 g of  $\text{C}_6\text{H}_{14}$ ?  
[A] 88.2 g      [B] 16.0 g      [C] 9.28 g      [D] 608 g      [E] 32.0 g
45. How many molecules of carbon dioxide would be formed if 6.75 g of propane is burned in the following reaction?  
 $\text{C}_3\text{H}_8(g) + 5\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 4\text{H}_2\text{O}(g)$   
[A]  $5.54 \times 10^{23}$  molecules      [B]  $2.77 \times 10^{23}$  molecules      [C]  $1.39 \times 10^{23}$  molecules  
[D]  $3.89 \times 10^{23}$  molecules      [E]  $20.3 \times 10^{23}$  molecules
46. The amount of energy needed to heat 2.00 g of carbon from  $50.0^\circ\text{C}$  to  $80.0^\circ\text{C}$  is 42.6 J. The specific heat capacity of this sample of carbon is  
[A] 0.710 J/g  $^\circ\text{C}$       [B] 0.355 J/g  $^\circ\text{C}$       [C] 2556 J/g  $^\circ\text{C}$   
[D] 639 J/g  $^\circ\text{C}$       [E] 1.42 J/g  $^\circ\text{C}$
47. Which of the following is a valid unit for specific heat (or specific heat capacity)?  
[A] cal      [B] g  $^\circ\text{C}/\text{cal}$       [C] cal/g      [D] cal/g  $^\circ\text{C}$       [E]  $^\circ\text{C}$

48. Heat is typically measured in [A] °F [B] °C [C] grams [D] joules
49. The form of EMR that has less energy per photon than microwaves is  
[A] gamma rays [B] microwaves [C] infrared rays  
[D] radio waves [E] none of these
50. The shape of an *s* orbital is  
[A] conical shaped [B] dumbbell shaped [C] donut shaped  
[D] spherical [E] none of these
51. A given set of *p* orbitals consists of \_\_\_\_\_ orbital(s).  
[A] 1 [B] 4 [C] 2 [D] 3 [E] 5
52. The maximum number of electrons allowed in each of the *d* orbitals is  
[A] 4 [B] 32 [C] 8 [D] 2 [E] 18
53. The electron configuration for the carbon atom is  
[A] [Ne]  $2s^2 2p^2$  [B]  $1s^2 2s^2 2p^2$  [C]  $1s^2 2p^4$  [D] [He]  $2s^4$  [E] none of these
54. The alkali metals have how many valence electrons?  
[A] 1 [B] 7 [C] 3 [D] 2 [E] 8
55. What element has the electron configuration  
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^2$ ?  
[A] Ba [B] Sn [C] Pb [D] Po [E] none of these
56. Which of the following atoms has the largest atomic radius?  
[A] C [B] P [C] Mg [D] Si [E] Na
57. Which of the following has the highest ionization energy?  
[A] C [B] K [C] Ca [D] N [E] O
58. Nonmetal elements typically have \_\_\_\_\_ electronegativities.  
[A] neutral [B] high [C] strong [D] low [E] none of these

59. An N--F bond is expected to be more polar than an O--F bond.  
[A] True [B] False
60. The most electronegative element is  
[A] O [B] He [C] Cs [D] At [E] F
61. Which of these is *not* an ionic compound?  
[A] NH<sub>4</sub>I [B] HCl [C] MgCl<sub>2</sub> [D] NaSCN [E] K<sub>2</sub>CO<sub>3</sub>
62. The number of polar covalent bonds in NH<sub>3</sub> is  
[A] 1 [B] 3 [C] 4 [D] 2 [E] none of these
63. Which element or ion listed below has the electron configuration 1s<sup>2</sup>2s<sup>2</sup>2p<sup>6</sup>?  
[A] Al<sup>3+</sup> [B] F<sup>-</sup> [C] Na<sup>+</sup> [D] Ne [E] all of these
64. How many lone pairs of electrons are in the Lewis structure for ammonia, NH<sub>3</sub>?  
[A] 1 [B] 0 [C] 2 [D] 4 [E] 3
65. Draw the Lewis electron structure for the HI molecule.
66. Draw the Lewis structure for CCl<sub>4</sub>.
67. Which of the following has a triple bond?  
[A] CH<sub>4</sub> [B] CO [C] NO<sub>3</sub><sup>-</sup> [D] SO<sub>2</sub> [E] none of these

Consider the molecule H<sub>2</sub>S. Answer the following.

68. What is the molecular geometry around the central atom?
69. How many lone pairs of electrons are around the central atom?
70. How many liters of HCl(g) measured at STP can be produced from 4.00 g of Cl<sub>2</sub> and excess H<sub>2</sub> according to the following equation:  
$$\text{H}_2(g) + \text{Cl}_2(g) \rightarrow 2\text{HCl}(g)$$

71. The solid rocket boosters for the space shuttle employ a mixture of aluminum and ammonium perchlorate (molar mass = 117 g/mol) as fuel. The balanced equation is
- $$3\text{Al}(s) + 3\text{NH}_4\text{ClO}_4(s) \rightarrow \text{Al}_2\text{O}_3(s) + \text{AlCl}_3(s) + 3\text{NO}(g) + 6\text{H}_2\text{O}(g)$$
- How many liters of gas measured at STP are produced from 235 g of  $\text{NH}_4\text{ClO}_4$  with excess aluminum?

[A] 135 L      [B] 44.8 L      [C] 404 L      [D] 15.9 L      [E] 220. L

[1] D

[2] D

[3] E

[4] D

[5] B

[6] E

[7] D

[8] A

[9] B

[10] C

[11] C

[12] D

[13] E

[14] B

[15] A

[16] D

[17] A

[18] [C]

[19] [C]

[20] [D]

[21] [E]

[22] [B]

[23] [B]

[24] [D]

[25] [C]

[26] [B]

[27] [D]

[28] [E]

[29] [E]

[30] 296

[31] 59.3 g

[32] [C]

[33] [E]

[34] [C]

[35] 54.8% Cd; 24.4% As; 20.8% O

[36] [D]

[37] [C]

[38]  $2\text{C}_6\text{H}_{14} + 19\text{O}_2 \rightarrow 12\text{CO}_2 + 14\text{H}_2\text{O}$

[39]  $\text{As}_2\text{O}_3(s) + 3\text{Ca}(\text{OH})_2(aq) \rightarrow \text{Ca}_3(\text{AsO}_4)_2(s) + 3\text{H}_2\text{O}(l)$

[40]  $4\text{Sb}(s) + 3\text{O}_2(g) \rightarrow 2\text{Sb}_2\text{O}_3(s)$

[41]  $2\text{KClO}_3(s) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(g)$

[42] [B]

[43] [C]

[44] [A]

[45] [B]

[46] [A]

[47] [D]

[48] [D]

[49] [D]

[50] [D]

[51] [D]

[52] D

[53] B

[54] A

[55] C

[56] E

[57] E

[58] B

[59] A

[60] E

[61] B

[62] B

[63] E

[64] A

[65]  $\text{H} - \ddot{\text{I}}:$   
\_\_\_\_\_

[66]  $\begin{array}{c} \text{:Cl:} \\ | \\ \text{:Cl}-\text{C}-\text{Cl:} \\ | \\ \text{:Cl:} \end{array}$   
\_\_\_\_\_

[67] [B]

[68] bent or V-shaped \_\_\_\_\_

[69] two lone pairs of electrons \_\_\_\_\_

[70] 2.53 L \_\_\_\_\_

[71] [A]