1. Which of the following is a heterogeneous mixture?

A. Grain alcohol (95% ethyl alcohol, 5% water)
B. Gardening soil
C. Sugar dissolved in water
D. Dry air (78% nitrogen, 22% oxygen)

2. What feature of solids makes them unique from liquids and gases?

A. Solids are not made of molecules
B. Solids have volume
C. Solids are compressible
D. Solids cannot flow

3. Which substance below is the best example of a pure compound?

A. carbonated soda
B. ice, $H_2O(s)$
C. argon, $Ar(g)$
D. diamond, $C(s)$

4. Which of the following is a chemical property?

A. Solubility of table salt in water
B. Flexibility of silver
C. Boiling point of water
D. Flammability of natural gas

5. Which of the following is **not** an extensive property of water?

A. Volume
B. Mass
C. Boiling point
D. Number of moles

6. Which one of the following statements about energy is **false**?

A. Kinetic energy is energy associated with position.
B. Systems with high potential energy tend to change in a direction that decreases their potential energy.
C. Energy is never created nor destroyed.
D. Energy is always conserved in a physical or chemical change.

7. Which prefix multiplier is the result of the following calculation?

$$(1\times10^{3}) \times (1\times10^{-6})$$

A. mega-
B. micro-
C. milli-
D. nano-

8. Multiply $(3.500 \times 10^{-3}) \times (4.46 \times 10^{5})$, expressing your answer in scientific notation.

A. 1.56×10^{-3}
B. 1.61×10^{-3}
C. 1.56×10^{3}
D. 1.6×10^{3}

9. What is the result of the following calculation to the correct number of significant figures?

$$1.27 \times 5.2 \times 3.14159 \div 8$$

A. 1.6
C. 2
B. 3
D. 1.60×10^2

10. What is the result of this calculation to the correct number of significant figures?

$$\frac{95.34 + 10.25}{(1.2056 \times 0.50100)}$$

A. 174.82
C. 43.879
B. 174.8
D. 43.88

11. A 62.34 g sample of solid uranium occupies a volume of 3.26 mL. What is the density of uranium?

A. 22 g/cm^3
C. 12.36 g/cm^3
B. 14.2 g/cm^3
D. 19.1 g/cm^3

12. The radius of an aluminum atom is 125 pm and the radius of an aluminum nucleus is 3.6×10^{-3} pm. What **percent** of the volume of the atom is occupied by the nucleus? Assume that both the atom and the nucleus are spherical. Volume of a sphere = $4/3\ \pi r^3$.

A. 2.9×10^{-3} %
C. 2.4×10^{-12} %
B. 1.9×10^{-11} %
D. 8.3×10^{-8} %

13. This summer, a new mode of public transportation called the Hyperloop was proposed. The inventor claims the Hyperloop could reach average speeds of 598 miles per hour. Assuming that you could travel at this speed on the Hyperloop, how long would it take to go from Lexington to Chicago, IL (358.8 miles)?

A. 36.0 minutes
C. 102 minutes
B. 6.0 minutes
D. 60.0 minutes

14. A box has a volume of 2.83 ft^3. What is its volume in liters?

A. 0.0863 L
C. 80.1 L
B. 0.100 L
D. 26.8 L

15. Which statement **is** consistent with Dalton's atomic theory?

A. Polonium becomes lead through a process called radioactive decay.
B. Palladium hydride can have formulas ranging from $PdH_{0.02}$ to $PdH_{0.58}$.
C. Rust forms when 3 atoms of oxygen combine with 2 atoms of iron.
D. One atom of bromine has a mass of 78.918 amu while another bromine atom has a mass of 80.916 amu.

16. The law that states that the proportion of elements in a compound is fixed is

A. The law of definite proportions
B. The law of density
C. The law of finite difference
D. The law of atomic dimensions

17. Which of the following statements about Thomson's experiments with cathode rays is **false**?

A. Cathode rays are composed of electrons.
B. The path of cathode rays can be altered by imposing both magnetic and electric fields.
C. Thomson successfully calculated the mass-to-charge ratio of the electron.
D. Thomson determined the mass of the proton.

18. Millikan's oil drop experiment

A. showed that an electron could have more than one charge.
B. proved that Thomson's "plum pudding" model of the atom's structure was correct.
C. demonstrated the existence of neutrons.
D. determined the charge on a single electron.

19. Nobel prize winner Ernest Rutherford conducted an experiment with gold foil and alpha particles, leading to the discovery that

A. most of an atom's mass is contained in a small core called the nucleus.
B. neutrons are positively charged.
C. an atom's mass is evenly distributed among its electrons.
D. atoms are comprised of small particles called quarks.

20. Which of these subatomic particles has a charge of 0?

A. electron
B. neutron
C. proton
D. zerotron

21. Complete the following table:

Atomic Number	*Charge*	*# of Electrons*	*Ion Symbol*
34	2–	***W* =**	***X* =**
16	***Y* =**	18	***Z* =**

A. $W = 34$, $X = \text{Se}$, $Y = 2–$, $Z = \text{Ar}^{2–}$
B. $W = 36$, $X = \text{Se}^{2+}$, $Y = 2+$, $Z = \text{S}^{2+}$
C. $W = 30$, $X = \text{Zn}^{2+}$, $Y = 2+$, $Z = \text{Ar}$
D. $W = 36$, $X = \text{Se}^{2–}$, $Y = 2–$, $Z = \text{S}^{2–}$

22. An atom has a mass number of 33, 16 electrons and a charge of 0. How many neutrons does this atom have?

A. 6 neutrons
B. 17 neutrons
C. 19 neutrons
D. 33 neutrons

23. How many protons, neutrons, and electrons are in a $^{51}V^{5+}$ ion?

A. 23 protons, 28 neutrons, 18 electrons
B. 18 protons, 28 neutrons, 23 electrons
C. 23 protons, 18 neutrons, 23 electrons
D. 23 protons, 28 neutrons, 28 electrons

24. How many protons (p), neutrons (n), and electrons (e) are in the following atom?

$^{87}_{37}Rb$

A. p = 50, n = 37, e = 50
B. p = 87, n = 30, e = 37
C. p = 37, n = 30, e = 50
D. p = 37, n = 50, e = 37

25. Which of the following pairs of elements would be expected to have the most similar chemical properties?

A. chlorine and oxygen
B. calcium and scandium
C. tin and lead
D. sulfur and arsenic

26. Gallium has an average atomic mass of 69.72 amu. Gallium exists as two naturally occurring isotopes, ^{69}Ga and ^{71}Ga with a natural abundance of 39.89% and an atomic mass of 70.92 amu. What is the atomic mass of ^{69}Ga?

A. 68.92 amu
B. 68.85 amu
C. 69.20 amu
D. 69.09 amu

27. How many nickel atoms are in 2.7 moles of nickel?

A. 6.3×10^{-25}
B. 1.6×10^{24}
C. 4.8×10^{-24}
D. 2.3×10^{23}

28. How many atoms are in a 98.3 g sample of sodium?

A. 1.39×10^{27}
B. 2.57×10^{24}
C. 7.10×10^{-24}
D. 9.52×10^{23}

29. Which of the following statements is *false*?

A. The value of the mole is equal to the number of atoms in exactly 12 grams of pure carbon-12.
B. One mole contains 6.022×10^{23} particles.
C. An element's molar mass in grams per mole is numerically equal to the element's atomic mass in amu
D. One mole of O_2 contains twice as many oxygen atoms as one mole of CO_2.

30. If a mole of Ne, Co and Ba each occupied the same volume, which would have the greatest density?

A. Ne
B. Co
C. Ba
D. They are all equal

Answer Key:

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