MULTIPLE CHOICE

1. Power is a measure of which of the following?
   a. Mechanical energy
   b. Gravitational potential energy
   c. The rate at which work is being performed
   d. The rate at which atoms and molecules move

   ANS: C
   Power is a measure of the rate at which work is being performed. The formula P = W/J, where W = watts and 1 watt is equal to 1 J/s, expresses this. Joules are the international standard for expressing energy and work.

   PTS: 1 REF: Page 3

2. When effort produces a change in the position of matter
   a. work is performed.
   b. it is known as a joule.
   c. mechanical power is created.
   d. the law of the conservation of energy is being used.

   ANS: A
   Work is performed only when effort or outside forces produce a change in the position of matter.

   PTS: 1 REF: Page 3

3. The unit used to express the force of 1 N acting on a 1-kg object to move it 1 m is which of the following?
   a. Watt
   b. Joule
   c. Kilowatt
   d. Kinetic energy (KE)

   ANS: B
   One joule is equal to the force of 1 N acting on 1 kg. A watt is equivalent to 1 J/s. A kilowatt is simply 1000 W. KE is energy an object possesses when it is in motion.

   PTS: 1 REF: Page 3

4. Power is expressed in which of the following units?
   a. Newtons
   b. Joules
   c. Ohms
   d. Watts

   ANS: D
   Power is a measure of the rate at which work is being performed. Energy and work are measured in joules. One joule is the force of 1 N acting on a 1-kg object to move it 1 m. Ohms is the resistance an electrical circuit possesses.

   PTS: 1 REF: Page 3

5. Four horsepower (hp) is equal to how many kilowatts (kW)?
   a. 5.36
   b. 2.98
   c. 2984
   d. 186.5

   ANS: B
   1 hp = 0.746 kW.
   1 hp/0.746 = 4 hp/X.
   $X = 4 \times 0.476 = 2.98$ kW.

   PTS: 1 REF: Page 3

6. The energy that an object possesses when it is in motion is called
   a. sound.
   b. kinetic.
   c. thermal.
   d. potential.

   ANS: B
   KE is the energy an object possesses when it stays in motion. Potential energy is stored energy, and it exists in many forms such as thermal energy or sound waves.

   PTS: 1 REF: Page 4

7. If the velocity of an object is reduced by half, its KE will be which of the following?
   a. Reduced to one-eighth
   b. Increased twofold
   c. Reduced twofold
   d. Not changed

   ANS: A
   Kinetic energy = 1/2(mass of object × square of velocity it is traveling, or mv^2) or KE = 1/2(V × V). If the velocity is reduced by half, then KE = 1/2(1/2V × 1/2V), or 1/2(1/2) = 1/8 reduction.

   PTS: 1 REF: Page 4

8. Energy that is stored in an object is called which of the following?
   a. Kinetic
   b. Potential
   c. Chemical
   d. Mechanical

   ANS: B
   Energy that is stored or possessed by an object because of its position is called potential energy. Mechanical energy can be divided into either KE or potential energy. Chemical potential energy often refers to the bonds in petroleum oils that, if broken, can be converted to KE.

   PTS: 1 REF: Page 4

9. The potential energy of a compressed spring is known as which of the following?
   a. Gravitational
   b. Chemical
   c. Inelastic
   d. Elastic

   ANS: D
   The potential energy stored in a compressed spring is called elastic potential energy. This energy is released when the spring is allowed to uncoil. Gravitational potential energy is the energy an object possesses if it is held above any surface, energy that the object's weight gains as it falls. Chemical potential energy resides in the chemical bonds of the atoms that make up the object. Inelastic potential energy would not apply once the spring is compressed.

   PTS: 1 REF: Page 4

10. The energy stored in heating oil is known as which of the following?
    a. Elastic
    b. Atomic
    c. Chemical
    d. Gravitational

    ANS: C
    Petroleum reserves of coal, oil, and gas represent chemical potential energy by virtue of the chemical bond that must be broken to release energy. Heating oil potential energy has chemical-to-chemical bonds. Atomic energy involves two processes—fission (splitting atoms) and fusion (joining two atoms).

    PTS: 1 REF: Page 3

11. The kinetic theory holds that
    a. all matter is composed of tiny particles.
    b. elements combine in fixed proportions to form molecules.
    c. the energy that an object gains as it falls is a result of gravity.
    d. atoms and molecules that make up matter are in constant motion.

    ANS: D
    KE is the energy an object possesses while in motion.

    PTS: 1 REF: Page 4

12. Which is the correct order for increasing size?
    a. Atoms, molecules, mixtures, compounds, elements
    b. Atoms, elements, molecules, compounds, mixtures
    c. Elements, atoms, molecules, compounds, mixtures
    d. Atoms, elements, mixtures, molecules, compounds

    ANS: B
    All matter, whether in gas, liquid, or solid form, is made up of atoms that can combine to form elements; the elements can then combine to form molecules. Molecules can combine to form compounds. Combining compounds makes a mixture.

    PTS: 1 REF: Page 4

13. Atoms and molecules arranged in an orderly fashion are called
    a. solids.
    b. mixtures.
    c. crystalline.
    d. amorphous.

    ANS: C
    Crystalline solids are highly organized structures whose atoms and molecules are arranged in a lattice configuration. Amorphous solids have atoms and molecules that are less rigidly arranged.

    PTS: 1 REF: Page 4

14. The most potential energy is contained by which state of matter?
    a. Gases
    b. Solids
    c. Liquids
    d. Mixtures

    ANS: B
    Of all states of matter, solids contain the most potential energy; solids are followed by liquids and then gases.

    PTS: 1 REF: Page 4

15. Which of the following are amorphous solids?
    1. Iron
    2. Glass
    3. Steel
    4. Margarine
    a. 1
    b. 1 and 3
    c. 2 and 4
    d. 2, 3, and 4

    ANS: C
    Glass and margarine are always considered amorphous solids. Steel and iron, however, have well-organized atoms in a crystalline arrangement.

    PTS: 1 REF: Page 4

16. Supercooled liquids are also known as which of the following?
    a. Elements
    b. Compounds
    c. Crystalline solids
    d. Amorphous solids

    ANS: D
    Amorphous solids are sometimes called supercooled liquids. Elements and compounds alone can combine to form either crystalline or amorphous solids.

    PTS: 1 REF: Page 4

17. The least amount of KE is possessed by which one of the following?
    a. Air
    b. Iron
    c. Water
    d. Plastic

    ANS: B
    Of the three states of matter, solids possess the least amount of KE. The bonds holding their atoms together limit the mobility of the particles that make up the solid.

    PTS: 1 REF: Page 4

18. Incompressible substances that are able to maintain their volume and shape are called
    a. gases.
    b. solids.
    c. liquids.
    d. compounds.

    ANS: B
    Solids are characterized as incompressible substances that can maintain their volume and shape. Gases and liquids do not maintain their volume and shape as well as solids do.

    PTS: 1 REF: Page 4

19. The weakest cohesive forces between constituent particles are present in which of the following?
    a. Water
    b. Plastic
    c. Hydrogen
    d. Liquid oxygen

    ANS: C
    Gases have extremely weak or no cohesive forces between their atoms. Hydrogen is the only gas among the four choices.

    PTS: 1 REF: Page 4

20. What forces must be overcome for evaporation to occur?
    1. The mass attraction of the molecules for each other
    2. The pressure of the gas above the liquid
    3. The decrease of KE
    4. The pressure of the gas below the liquid
    a. 1 and 4
    b. 1 and 2
    c. 2 and 3
    d. 3 and 4

    ANS: B
    Two forces must be overcome for evaporation to occur: the mass attraction of the molecules for each other (i.e., dipole–dipole interactions, hydrogen bonding, and Van der Waals forces) and the pressure of the gas above the liquid.

    PTS: 1 REF: Page 6

21. The temperature at which a solid converts to a liquid is the _____ point.
    a. freezing
    b. melting
    c. boiling
    d. critical

    ANS: B
    This is the definition of melting point. Freezing is the change of a substance from a liquid to a solid. Melting is the change from a solid to a liquid. The temperature at which a liquid converts to a gaseous state is the boiling point. The critical point is used to describe the critical temperature and critical pressure of a substance.

    PTS: 1 REF: Page 7

22. Which of the following statements are true concerning the latent heat of fusion?
    1. It is also called evaporation.
    2. It is expressed in calories per gram.
    3. It will cause a complete change of state.
    4. It is expressed in grams per degree Celsius.
    a. 1 and 2
    b. 1 and 3
    c. 2 and 3
    d. 2, 3, and 4

    ANS: C
    Latent heat of fusion is the amount of heat, in calories, that must be added to cause a complete change of state. Evaporation is change from liquid to gas. Latent heat is expressed as calories per gram. Evaporation is the passive change of state over time, with no addition of heat.

    PTS: 1 REF: Page 7

23. The process whereby a solid directly becomes a gas is known as
    a. latent heat.
    b. sublimation.
    c. evaporation.
    d. condensation.

    ANS: B
    The direct change of state from solid to gas is called sublimation. Evaporation involves change from liquid to gas. Latent heat involves a change of state in matter of any form.

    PTS: 1 REF: Page 5

24. Which two of the following are ways to increase the rate of evaporation?
    1. Decrease the temperature of the liquid
    2. Increase the temperature of the liquid
    3. Decrease atmospheric pressure
    4. Increase atmospheric pressure
    a. 1 and 3
    b. 1 and 4
    c. 2 and 3
    d. 2 and 4

    ANS: C
    The rate of evaporation increases with an increase in temperature, an increase in surface area, or a decrease in pressure.

    PTS: 1 REF: Page 6

25. How much pressure must be applied to maintain equilibrium between liquid and gaseous oxygen at its critical temperature?
    a. 1 atm
    b. 37 atm
    c. 43.9 atm
    d. 49.7 atm

    ANS: D
    When the atmospheric pressure is maintained at 49.7 atm, at a temperature of –119°C (oxygen's critical temperature), oxygen maintains an equal balance between its liquid and gaseous states.

    PTS: 1 REF: Page 7

26. The temperature at which a liquid converts to a gaseous state is known as which of the following?
    a. Critical temperature
    b. Vapor pressure
    c. Boiling point
    d. Latent heat

    ANS: C
    The boiling point is the temperature at which the vapor pressure of a liquid equals atmospheric pressure. Critical temperature is the temperature above which gases cannot convert back to liquid. Critical pressure is the amount of pressure applied at the critical temperature to maintain balance between the liquid and gas phases.

    PTS: 1 REF: Page 7

27. The temperature above which gas molecules cannot be converted back to a liquid, no matter how much pressure is exerted, is known as which of the following?
    a. Critical temperature
    b. Critical point
    c. Boiling point
    d. Latent heat

    ANS: A
    This is the definition of critical temperature.

    PTS: 1 REF: Page 7

28. The boiling point of liquid oxygen is which of the following?
    a. –119°C
    b. 182°F
    c. –183°C
    d. 49.7°C

    ANS: C
    This is the boiling point of liquid oxygen.

    PTS: 1 REF: Page 6

29. Which two of the following are considered vapors?
    1. Carbon dioxide
    2. Nitrogen
    3. Oxygen
    4. Nitrous oxide
    a. 1 and 3
    b. 1 and 4
    c. 2 and 3
    d. 2 and 4

    ANS: B
    Substances such as nitrous oxide and carbon dioxide have critical temperatures above room temperature and thus can exist as vapors.

    PTS: 1 REF: Page 7

30. How many degrees Fahrenheit is 200°K?
    a. –99.4°F
    b. –58.3°F
    c. 32°F
    d. 0°F

    ANS: A
    Use the formula in Box 1.3 to calculate this conversion.

    PTS: 1 REF: Page 9

31. Absolute zero is which of the following?
    a. 0°K
    b. The freezing point of water
    c. Routinely measured in Fahrenheit
    d. The temperature at which all molecular motion stops

    ANS: A
    On the Kelvin scale, 0°K is absolute zero.

    PTS: 1 REF: Page 8

32. 20°C equals how many Kelvin?
    a. 32°K
    b. 68°K
    c. 253°K
    d. 293°K

    ANS: D
    See Fig. 1.3 in the textbook.

    PTS: 1 REF: Page 9

33. How many degrees Celsius is 373°K?
    a. 32°C
    b. 100°C
    c. 273°C
    d. 341°C

    ANS: B
    See Box 1.3.

    PTS: 1 REF: Page 9

34. How many degrees Fahrenheit is 100°K?
    a. –331°F
    b. –279°F
    c. –173°F
    d. 212°F

    ANS: B
    See Box 1.3.

    PTS: 1 REF: Page 9

35. How many degrees Fahrenheit is 425°K?
    a. 152°F
    b. 274°F
    c. 306°F
    d. 698°F

    ANS: C
    See Box 1.3.

    PTS: 1 REF: Page 9

36. Which two of the following temperatures are not equal?
    1. 15°C = 288°K
    2. 98.6°C = 32°F
    3. 20°F = –6.7°C
    4. 100°C = 273°K
    a. 2 and 4
    b. 1 and 3
    c. 3 and 4
    d. 1 and 2

    ANS: A
    See Box 1.3.

    PTS: 1 REF: Page 9

37. How many degrees Celsius is 101°F?
    a. 24°C
    b. 145°C
    c. 38.3°C
    d. 56.1°C

    ANS: C
    See Box 1.3.

    PTS: 1 REF: Page 9

38. How many degrees Kelvin is 25°F?
    a. 298°K
    b. 277°K
    c. 269°K
    d. 266°K

    ANS: C
    See Box 1.3.

    PTS: 1 REF: Page 9

39. How many millimeters of mercury is 25 cm H_2O?
    a. 2.45
    b. 18.4
    c. 188
    d. 34

    ANS: B
    See Box 1.4.

    PTS: 1 REF: Page 9

40. How many kilopascals are equal to 15 mm Hg?
    a. 2
    b. 11
    c. 153
    d. 1.47

    ANS: A
    See Box 1.4.

    PTS: 1 REF: Page 9

41. A reduction in the force of gravity will cause the atmospheric pressure to
    a. shift.
    b. increase.
    c. decrease.
    d. remain constant.

    ANS: C
    Atmospheric pressure is highest at sea level. An increase in altitude will cause atmospheric pressure to decrease, which leads to a decrease in the force of gravity.

    PTS: 1 REF: Page 9

42. What are the two opposing forces in a mercury barometer?
    a. The weight of the mercury column and the force of the gas molecules
    b. The weight of the mercury column and the spring tension
    c. The spring tension and the gas pressure
    d. The gravity and the gas pressure

    ANS: A
    In a mercury barometer the weight of a column of mercury must equilibrate with the force of the gas molecules.

    PTS: 1 REF: Page 10

43. The effects of buoyancy are best explained by
    a. Archimedes principle.
    b. Bernoulli principle.
    c. Dalton’s law.
    d. Boyle’s law.

    ANS: A
    Buoyancy occurs when an object is submerged in water. The object feels lighter than it is above water. The Bernoulli principle, Dalton’s law, and Boyle’s law relate to how gases or fluids vary with changes in pressure, volume, or temperature.

    PTS: 1 REF: Page 10

44. Specific gravity is best described as which of the following?
1. A measure of density
2. An application of Archimedes principle
3. A measurement that can be performed on liquids only
4. An application of Boyle's law
a. 1 and 4
b. 1 and 2
c. 2 and 3
d. 2, 3, and 4

ANS: B
Specific gravity calculations use Archimedes principle in comparing a substance's weight and density relative to a standard. The measurement of specific gravity can also be applied to gases.

PTS: 1 REF: Page 10

45. The viscosity of a fluid is primarily determined by
1. the cohesive forces between its molecules.
2. its density.
3. the number of collisions of the molecules.
4. free flow.
a. 1
b. 1 and 2
c. 3 and 4
d. 2 and 4

ANS: B
Viscosity can be defined as the force opposing deformation of a fluid. The viscosity of a fluid depends on its density and on the cohesive forces between its constituent molecules (i.e., as the cohesive forces of a fluid increase, so does its viscosity).

PTS: 1 REF: Page 11

46. In which of the following substances can sublimation take place?
a. Dry ice
b. Gelatin (e.g., Jell-O)
c. Water
d. Glass

ANS: A
This process, called sublimation, occurs when the heat content of a substance increases to a point at which the molecules in the solid state gain enough energy to break loose and enter the gaseous state while remaining below its melting point. The conversion of solid carbon dioxide (i.e., dry ice) to gaseous carbon dioxide is the most common example of this process.

PTS: 1 REF: Page 5

47. A hydrometer is usually associated with measuring which of the following?
1. Hydrogen content
2. Specific gravity
3. Weight density
4. Water vapor
a. 1 and 3
b. 2 and 4
c. 2 and 3
d. 1, 2, and 3

ANS: C
Hydrometers are used to measure the weight density or specific gravity of liquids.

PTS: 1 REF: Page 10

48. Which of the following are components in respiration?
1. Sublimation
2. Condensation
3. Evaporation
4. Vaporization
a. 1
b. 2 and 3
c. 2 and 4
d. 1, 2, and 4

ANS: B
Evaporation and condensation are essential components of respiration. Specifically, effective ventilation requires a balance between the evaporation and condensation of the moisture of respired gases so that the airway mucosa are not dried and irritated.

PTS: 1 REF: Page 6

49. Forces at the molecular interface between oil and water are known as _____ forces.
    a. van der Waals
    b. hydrostatic
    c. cohesive
    d. adhesive

    ANS: C
    Surface tension is generated by the cohesive forces of molecules at a gas–liquid interface or at the interface of two immiscible liquids, such as oil and water. Adhesive forces are attractive forces between two different kinds of molecules, and van der Waals forces are physical intermolecular forces that cause molecules to be attracted to each other.

    PTS: 1 REF: Page 11

50. Surface tension is present in a container with which of the following?
    a. Oxygen and hydrogen
    b. Water and mercury
    c. Water and chlorine
    d. Water and salt

    ANS: B
    When water and mercury are mixed together, they will separate into two distinct liquids because of surface tension. Oxygen and hydrogen will combine to form water. Both salt and chlorine will dissolve in water easily.

    PTS: 1 REF: Page 11

51. A small-diameter glass tube is placed upright in a container of mercury. The meniscus at the top of the column of mercury is convex. This demonstrates that the
    a. cohesive forces of mercury are weak.
    b. cohesive forces of mercury are strong.
    c. adhesive forces within the mercury are strong.
    d. adhesive forces between the mercury and the glass are strong.

    ANS: B
    The cohesive forces within the mercury are stronger than the adhesive forces between the mercury and the glass. If the cohesive forces within the mercury were weaker than the adhesive forces, the meniscus would be concave. See Box 1.5.

    PTS: 1 REF: Page 11

52. According to the Système International d'Unités, surface tension is measured in
    a. cc^3.
    b. lb/in^2.
    c. lb/cc^3.
    d. dyne/cm.

    ANS: D
    In the Système International d'Unités system of measurements, surface tension is measured in dyne per centimeter.

    PTS: 1 REF: Page 12

53. Which substance has the lowest surface tension?
    a. Water at 20°C
    b. Water at 37°C
    c. Blood at 37°C
    d. Ethyl alcohol at 20°C

    ANS: D
    See Table 1.2.

    PTS: 1 REF: Page 12

54. The surface tension of a liquid
    a. does not vary with temperature.
    b. increases as temperature increases.
    c. increases as temperature decreases.
    d. decreases as temperature increases.

    ANS: D
    The surface tension of any given liquid varies inversely with its temperature. Adding heat to a liquid causes the molecules to move more vigorously and break the bonds that are holding them in liquid form.

    PTS: 1 REF: Page 11

55. According to Laplace's law, if the surface tension of a sphere is doubled, what will happen to the pressure within the sphere?
a. The pressure will decrease by one half.
b. The pressure will increase by one half.
c. The pressure will quadruple.
d. The pressure will double.

ANS: D
Laplace's law, P = 2(ST/r), states that the pressure within a sphere is directly related to the surface tension of the liquid and inversely related to the radius of the sphere; that is, both surface tension and pressure within a sphere will change equally in the same proportion.

PTS: 1 REF: Page 11

56. What will happen to the surface tension of water droplets when a surface-active agent is added?
a. Nothing will happen.
b. It will increase.
c. It will decrease.
d. It will be eliminated.

ANS: C
Surface tension is the force exerted by like molecules at the liquid's surface. The introduction of a surface-active agent (e.g., soap) would decrease the cohesive forces between the water droplets, thus reducing their surface tension at the surface. With liquids (e.g., water), surface tension can be made to increase or decrease, but it cannot be eliminated. See Fig. 1.9.

PTS: 1 REF: Page 11

57. Which of the following shows the correct relationship among density, volume, and mass?
1. Density = volume/mass
2. Volume = density/mass
3. Mass = (density)/(volume)
4. Weight density = weight/volume
a. 1 and 3
b. 1 and 4
c. 2 and 3
d. 3 and 4

ANS: D
Given density, d = mass (m)/volume (v), the equation can be solved for each variable: m = dv, v = m/d. When mass is substituted by weight, dw = w/v.

PTS: 1 REF: Page 10

58. Under what conditions is the relationship between mass and weight constant?
a. In outer space
b. At zero gravity
c. At the center of the Earth
d. Near the surface of the Earth

ANS: D
Near the surface of the Earth, two equations apply: d = m/v, dw = w/v. In space and at zero gravity, weight is not a factor; at the Earth's core, extreme gravitational forces would increase the weight as mass remained constant.

PTS: 1 REF: Page 10

59. For solids and liquids, density can be expressed in which of the following units?
1. g/L
2. mg/mL
3. g/cc
4. L/cc
a. 1
b. 2 and 3
c. 2 and 4
d. 1, 2, and 3

ANS: D
For solids and liquids, density = grams (g)/liter (L) or grams (g)/cubic centimeter (cm^3). Using d = g/L, divide both sides by 1000. Density can also be expressed in mg/mL.

PTS: 1 REF: Page 10

60. Boyle's law describes the relationship between which of the following?
    a. Pressure and temperature
    b. Volume and temperature
    c. Volume and pressure
    d. Pressure and density

    ANS: C
    Boyle's law states that at a constant temperature, the volume of a gas varies inversely proportional to pressure [V = 1/P]. The relationship between volume and temperature is expressed in Charles' law. The relationship between pressure and temperature is described by Gay-Lussac's law.

    PTS: 1 REF: Page 13

61. If temperature is constant, which pressure results in the largest volume?
    a. 15 mm Hg
    b. 760 mm Hg
    c. 1520 mm Hg
    d. 2000 mm Hg

    ANS: A
    See Fig. 1.10.

    PTS: 1 REF: Page 7

62. Which of the following formulas represents Boyle's law?
    a. $V = 2P$
    b. $V = 1/2P$
    c. $P_1V_1 = P_2V_2$
    d. $P_1/P_2 = V_1/V_2$

    ANS: C
    Boyle's law can be expressed as a ratio: $P_1V_1 = P_2V_2$.

    PTS: 1 REF: Page 13

63. The relationship of how the volume of a gas varies with temperature is known as _____ law.
    a. Gay-Lussac's
    b. Newton's
    c. Charles'
    d. Boyle's

    ANS: C
    The relationship between pressure and volume is described by Boyle's law; between volume and temperature, by Charles' law; between pressure and temperature, by Gay-Lussac's law. Newton detailed the many relationships of gravitational force and motion.

    PTS: 1 REF: Page 13

64. Which of the following formulas represents Gay-Lussac's law?
    a. $P_1/T_1 = T_2/P_2$
    b. $P_1/T_1 = P_2/T_2$
    c. $P_1T_2 = P_2T_1$
    d. $P = 1/T$

    ANS: B
    Gay-Lussac expressed the relationship between pressure and temperature. If $P/T = K$ (where K = constant), then $P_1/T_1 = P_2/T_2$.

    PTS: 1 REF: Page 13

65. Which gas law describes the relationship between the temperature and pressure of a gas when volume is constant?
    a. Gay-Lussac's law
    b. Charles' law
    c. Dalton's law
    d. Boyle's law

    ANS: A
    Gay-Lussac expressed the relationship between pressure and temperature.

    PTS: 1 REF: Page 13

66. The direct relationship between the volume and temperature of a gas is the basic principle of _____ law.
    a. Gay-Lussac's
    b. Charles'
    c. Dalton's
    d. Boyle's

    ANS: B
    Charles' law is stated as follows: that the volume of a given amount of gas held at a constant pressure increases proportionately with increases in the temperature of the gas. The relationship between volume and temperature can be explained by the fact that as the temperature of the gas increases, the KE of the gas molecules increases.

    PTS: 1 REF: Page 13

67. It is implied that the absolute temperature of a gas will rise as the pressure is increased when which of the following occurs?
    a. Absolute temperature of the gas reaches absolute zero
    b. Size of the container remains constant
    c. Volume of the gas is held constant
    d. Volume of the gas is increased

    ANS: C
    When the volume of a gas is constant, the temperature of the gas will rise as the pressure is increased (Gay-Lussac's law). Absolute zero is a theoretical temperature that has never been reached. The size of the container does not vary directly with volume.

    PTS: 1 REF: Page 13

68. The combined-gas law best describes which of the following?
    a. The behavior of all gases when volume is constant
    b. The combined behavior of pressure, volume, and temperature
    c. The additive properties of individual gases occupying the same space
    d. The macroscopic behavior of gases when any or all variables change simultaneously

    ANS: D
    The combined-gas law describes the macroscopic behavior of gases when any or all of the variables change simultaneously. As such, the combined-gas law states that the absolute pressure of a gas is inversely related to the volume it occupies and directly related to its absolute temperature, or PV/T = nR.

    PTS: 1 REF: Page 13

69. Which is the correct formula for the principles of the combined-gas law?
    a. $P_1V_1/T_1 = P_2V_2/T_2$
    b. $PVT = nR$
    c. $P_1V_1/T_2 = P_2V_2/T_1$
    d. $T_2/P_1V_1 = T_1/P_2V_2$

    ANS: A
    That is the formula for the combined-gas law.

    PTS: 1 REF: Page 14

70. In the combined-gas law, n represents
    a. Boltzmann's universal gas constant.
    b. the atomic mass of the gas.
    c. the number of moles of gas.
    d. the partial pressure of a gas.

    ANS: C
    Boltzmann's constant is represented as R. The combined-gas laws do not use the atomic mass or the partial pressure of any gas as a variable in any calculations presented in answers B and D.

    PTS: 1 REF: Page 14

71. The sum of the partial pressures of a gas mixture equals the total gas pressure of the system. This statement represents which of the following laws?
    a. Dalton's law
    b. Avogadro's law
    c. The combined-gas law
    d. Boltzmann's Universal Gas Constant

    ANS: A
    The correct answer is Dalton's law. This law states that the total pressure of a gas is equal to the sum of the partial pressure of the gases that make up the mixture. The partial pressure of a gas within a gas mixture can be calculated by multiplying the total pressure of the mixture by the percentage of the mixture it occupies.

    PTS: 1 REF: Page 14

72. The partial pressure of a gas can be obtained by doing which of the following?
    a. Multiplying the total mixture pressure by the percentage area a particular gas occupies
    b. Multiplying the atmospheric pressure by the percentage of water vapor present
    c. Subtracting the partial pressure of water vapor from the atmospheric pressure
    d. Dividing the total pressure of a gas mixture by the atmospheric pressure

    ANS: A
    Dalton's law states that the sum of the partial pressures of a gas mixture equals the total pressure of the system. Therefore, the partial pressure of a single gas may be calculated by multiplying the percentage of the gas in the gas mixture by the total pressure.

    PTS: 1 REF: Page 14

73. The partial pressure of nitrogen at 1 atm is _____ mm Hg.
    a. 661.2
    b. 592.8
    c. 159.6
    d. 0.228

    ANS: B
    The partial pressure of nitrogen can be calculated by multiplying the barometric pressure by the percentage of nitrogen in the air, or 760 mm Hg × 0.78 = 592.8 mm Hg.

    PTS: 1 REF: Page 14

74. The partial pressure of oxygen when there is 25% oxygen in a gas mixture at an atmospheric pressure of 760 mm Hg is ____ mm Hg.
    a. 190
    b. 30.4
    c. 1900
    d. 159.6

    ANS: A
    Partial pressure of oxygen = % oxygen × barometric pressure, or 0.25 × 760 mm Hg = 190 mm Hg.

    PTS: 1 REF: Page 14

75. Which of the following does not follow Dalton's law at sea level?
    a. Oxygen
    b. Nitrogen
    c. Water vapor
    d. Trace gases

    ANS: C
    Water vapor pressure does not follow Dalton's law because such pressure primarily depends upon temperature. Water vapor pressure must be subtracted from the total pressure of a given mixture if the gas mixture is saturated with water.

    PTS: 1 REF: Page 14

76. One mole of any gas will occupy 22.4 L and contain _____ molecules.
    a. 6.02×10^{23}
    b. 6.2×10^{23}
    c. 0.602×10^{23}
    d. 6.2×10^{-23}

    ANS: A
    1 mole of oxygen (mw = 32 g) occupies a volume of 22.4 L and contains 6.02×10^{23} molecules when measured at 0°C (273°K) and 1 atm.

    PTS: 1 REF: Page 15

77. A practical application of Avogadro's law is seen in the calculation of which of the following?
    1. Specific gravity
    2. Diffusion rate
    3. Gas density
    4. Osmosis
    a. 1 and 2
    b. 1 and 3
    c. 2 and 4
    d. 3 and 4

    ANS: B
    A practical application of Avogadro's law is seen in the calculation of gas densities and specific gravity.

    PTS: 1 REF: Page 15

78. The molecular weight of a gas divided by 22.4 L is used to express which of the following?
    a. Density
    b. Diffusion rate
    c. Partial pressure
    d. Specific gravity

    ANS: A
    The density of a gas per unit volume can be calculated with the following formula: Density (gm/L) = mw of gas/22.4 L.

    PTS: 1 REF: Page 15

79. At what temperature would you expect to see the highest water–vapor pressure?
    a. 0°C
    b. 40°C
    c. 100°C
    d. Absolute zero

    ANS: C
    The higher the temperature, the more water vapor a gas can hold.

    PTS: 1 REF: Page 15

80. The movement of gas molecules from an area of high concentration to one of lower concentration describes the property of which of the following?
    a. Osmosis
    b. Effusion
    c. Diffusion
    d. Suspension

    ANS: C
    Diffusion is movement of molecules from areas of high concentrations to low concentrations. Effusion refers to the seepage or loss of blood through torn blood vessels. Osmosis describes the movement of water across a semipermeable membrane from a less-concentrated to a more-concentrated area. Suspensions are mixtures of solutions with undissolved particles or molecules.

    PTS: 1 REF: Page 15

81. Which gas has the lowest specific gravity at 25°C and 760 mm Hg?
    a. Water vapor
    b. Helium
    c. CO_2
    d. O_2

    ANS: B
    See Fig. 1.13.

    PTS: 1 REF: Page 15

82. Which law states that when two gases are placed under the same temperature and pressure, the rates of diffusion of both gases are inversely proportional to the square root of their densities?
    a. Graham's law
    b. Henry's law
    c. Mole's law (also known as the ideal gas law)
    d. Fick's law

    ANS: A
    Graham's law states that when two gases are placed under the same temperature and pressure conditions, the rates of diffusion of the two gases are inversely proportional to the square root of their masses, or $r_1/r_2 = \sqrt{M_2/M_1}$, where r_1 and r_2 represent the diffusion rates of the respective gases and M_1 and M_2 are the molar masses.

    PTS: 1 REF: Pages 15-16

83. Which of the following formula(s) best represent(s) Graham's law?
    I. $c \propto p \times s$
    II. $r_1/r_2 = \sqrt{d_2/d_1}$
    III. $D = S \div \sqrt{MW}$
    IV. $r_1/r_2 = \sqrt{M_2/M_1}$
    a. 1
    b. 3
    c. 2 and 4
    d. 3 and 4

    ANS: C
    Graham's law states that when two gases are placed under the same temperature and pressure conditions, the rates of diffusion of the two gases are inversely proportional to the square root of their masses, or $r_1/r_2 = \sqrt{M_2/M_1}$, where r_1 and r_2 represent the diffusion rates of the respective gases, and M_1 and M_2 are the molar masses. If the mass of a gas is considered directly proportional to its density at a constant temperature and pressure, then $r_1/r_2 = \sqrt{d_2/d_1}$ where d_1 and d_2 are the densities of the gases in question.

    PTS: 1 REF: Pages 15-16

84. In the formula for Henry's law, the c represents which of the following?
    a. Mass
    b. Density
    c. Solubility
    d. Partial pressure

    ANS: A
    c is the molar concentration (in mol/L) of the dissolved gas.

    PTS: 1 REF: Page 16

85. The law that describes the diffusion of a gas across a semipermeable membrane is _____ law.
    a. Fick's
    b. Henry's
    c. Graham's
    d. Charles'

    ANS: A
    Fick's law represents the flow of gases across semipermeable membranes. Henry's law explains the relationship of a gas and a liquid in a combined space. Graham's law involves the relationship of multiple gases placed under the same temperature and pressure, and Charles' law states that the volume of gas varies directly with changes in temperature.

    PTS: 1 REF: Page 16

86. Fluid mechanics is a branch of physics that involves which of the following?
    1. Hydrodynamics
    2. Fluids in motion
    3. Thermodynamics
    4. Electrical properties of gases
    a. 2
    b. 1 and 2
    c. 1 and 4
    d. 3 and 4

    ANS: B
    Fluid mechanics deals with the behavior of fluids in motion and involves fluid dynamics. Hydrodynamics is the study of fluids in motion.

    PTS: 1 REF: Page 16

87. Which of the following terms does not describe a pattern of flow?
    a. Tubular
    b. Laminar
    c. Turbulent
    d. Transitional

    ANS: A
    Tubular is the only word in the list that does not describe a pattern of flow.

    PTS: 1 REF: Page 17

88. When the movement of fluid molecules is streamlined, this flow is normally described as
    a. straight.
    b. laminar.
    c. turbulent.
    d. aerodynamic.

    ANS: B
    In laminar flow, the fluid flows in discrete cylindrical layers or streamlines. With turbulent flow, the movement of fluid becomes chaotic. Straight and aerodynamic are not terms that are used to describe the way fluid moves.

    PTS: 1 REF: Page 17

89. Fluid movement that is chaotic is known as
    a. random.
    b. turbulent.
    c. streamlined.
    d. transitional.

    ANS: B
    With turbulent flow, the movement of fluid molecules becomes chaotic and the orderly pattern of concentric layers seen with laminar flow is lost. Transitional flow is the mixture of laminar and turbulent flows. If the movement of fluid is said to be streamlined, it is laminar. Fluid mechanics does not describe the flow of fluids as being random.

    PTS: 1 REF: Page 17

90. When tubes have one or more branches, the flow becomes
    a. transitional.
    b. restricted.
    c. turbulent.
    d. laminar.

    ANS: A
    Transitional flow is a mixture of laminar and turbulent flows that typically occur where tubes divide. See Fig. 1.15. Restricted flow occurs when narrowing or constrictions occur along the length of a tube. Laminar and turbulent flows can become restricted if an obstruction is encountered along the length of a tube.

    PTS: 1 REF: Page 17

91. The relationship between pressure, flow, and resistance for a liquid flowing through a tube represents
    a. Reynolds' number.
    b. Poiseuille's law.
    c. Venturi principle.
    d. Bernoulli principle.

    ANS: B
    When considering the flow of a liquid through a tube, you should take two factors into consideration: the driving pressure forcing the fluid and the resistance the liquid must overcome as it flows. Reynolds suggested that fluid flow becomes turbulent when velocity is increased or when there are changes in fluid density or viscosity and the radius of the tube. The Venturi and Bernoulli principles deal with the relationship between a liquid's forward velocity and tubular lateral-wall pressure.

    PTS: 1 REF: Page 17

92. Applying the principles of Poiseuille's law, which statement is true?
    a. The resistance offered by a tube is inversely proportional to its length.
    b. As the radius of a tube decreases, the pressure gradient increases.
    c. The more viscous the fluid, the easier it is to move the fluid through a tube.
    d. The driving pressure of a gas is indirectly proportional with the length of the tube.

    ANS: B
    Poiseuille's law can be rewritten as: $\Delta P = Q \times [(8nl)/(\Pi r4)]$. According to this equation, the following statements can be made. The more viscous a fluid, the greater the pressure gradient required to cause it to move through a given tube. The resistance offered by a tube is directly proportional to its length. The pressure required to achieve a given flow through a tube must increase in direct proportion to the length of the tube. The resistance to flow is inversely proportional to the fourth power of the radius. Small changes in the radius of a tube will cause profound increases in the resistance to flow through that tube.

    PTS: 1 REF: Page 17

93. When you discuss the mechanics of breathing, which expression of Poiseuille's law do you use?
    a. $P = \dot{Q} \times R$
    b. $\dot{Q} = P \div R$
    c. $\dot{V} = P \div R$
    d. $\dot{Q} = 1/\dot{V}$

    ANS: C
    Poiseuille's law states that the pressure gradient required to cause a liquid to move through a tube is equal to the flow of the liquid through the tube multiplied by the resistance to flow. In a discussion of gases, the term flow of the liquid is replaced with flow of the gas. Therefore, the flow of the gas is equal to the pressure gradient divided by the resistance to flow.

    PTS: 1 REF: Page 17

94. Reynolds' number is derived from which of the following components?
    a. Velocity of flow, radius of tube, density of gas, and velocity of gas
    b. Velocity of flow, length of tube, density of gas, and velocity of gas
    c. Velocity of gas, radius of tube, viscosity of flow, and density of gas
    d. Flow asymmetry, shape of tube, density of gas, and length of tube

    ANS: A
    The formula for Reynolds' number is $N_R = v \times d \times (2r/\eta)$, where *v* is the velocity of the flow; r is the radius of the tube, and d and η are the density and velocity of the gas, respectively.

    PTS: 1 REF: Pages 18-19

95. As a fluid flows through a tube of uniform diameter, pressure drops progressively over the length of the tube. This illustrates an application of which of the following?
    a. Coanda effect
    b. Venturi principle
    c. Bernoulli principle
    d. Reynolds' number

    ANS: C
    Bernoulli stated that "As the forward velocity of a gas, or liquid, moving through a tube increases, the lateral wall pressure of the tube will decrease." Venturi postulated that pressure drops of fluids moving through constriction along a tube can be reversed if there is gradual dilation in the tube distal to the constriction. The Coanda effect is also based on the Bernoulli principle and demonstrates that water or gas flow can be deflected through a full 180 degrees by careful placement of postconstriction extensions. Reynolds' number is the result of this mathematical equation: $N_R = v \times d \times (2r/\eta)$. The turbulent flow is greater when the Reynolds' number exceeds 2000.

    PTS: 1 REF: Pages 18-19

96. Following the Bernoulli principle, when a fluid approaches a constriction in a tube, there will be a(n) ____ in acceleration and a(n) ____ in lateral pressure.
    a. decrease, decrease
    b. decrease, increase
    c. increase, decrease
    d. increase, increase

    ANS: C
    As fluid approaches a constriction in a tube, the flow of the liquid will accelerate (increase) as it enters the constriction, which in turn causes a decrease in lateral-wall pressure.

    PTS: 1 REF: Pages 18-19

97. The pressure drop resulting from a constriction in a tube can be restored by which of the following?
    a. An increase in flow rate
    b. A postconstriction increase in radius
    c. The addition of another entrainment port
    d. A further decrease in the radius of the tube

    ANS: B
    This question involves the Venturi principle, which states that the pressure drop caused by fluid flowing through a tubular constriction can be restored to preconstriction values by allowing for a gradual dilation in the tube.

    PTS: 1 REF: Page 18

98. Placement of postconstriction extensions in a tube can deflect a flow 180 degrees along a new wall contour. This phenomenon illustrates the
    a. Coanda effect.
    b. Venturi principle.
    c. Bernoulli principle.
    d. Bernoulli–Coanda inversion.

    ANS: A
    Coanda was able to demonstrate that, with careful placement of the postconstriction extensions, he could deflect a stream of air through a full 180-degree turn by extending the wall contour.

    PTS: 1 REF: Page 18

99. Electricity can be represented by the flow of which of the following?
    a. Negative ions through a nonconductive path
    b. Negative ions over a nonconductive circuit
    c. Electrons through a piece of copper wire
    d. Electrons in a bidirectional path

    ANS: C
    Electricity is produced by the flow of electrons through a conductive material such as copper. Electricity cannot flow through nonconductive material or simultaneously run bidirectionally along the same path.

    PTS: 1 REF: Page 19

100. An electrical current is influenced by which of the following?
1. Voltage
2. Resistance
3. Electromotive forces
4. The number of insulators
a. 1 and 2
b. 2 and 4
c. 3 and 4
d. 3 and 4

ANS: A
Electrical currents are influenced by voltage (the electromotive force pushing electrons forward) and the resistance electrons must overcome along the conductive pathway. An insulator is the material surrounding the conductive material and is usually made of plastic.

PTS: 1 REF: Page 19

101. The standard unit of measure of an electrical current is which of the following?
a. Milliampere
b. Coulomb
c. Ampere
d. Volt

ANS: C
The standard unit of measurement of electrical current is the ampere (A), where 1 A is equivalent to 6.25×10^{18} electrons passing a point in 1 second. The term *coulomb* is used as a shorthand notation for 6.25×10^{18} electrons. The standard unit of measurement for voltage is the *volt* (V). A milliampere is equal to 0.001 A.

PTS: 1 REF: Page 19

102. Which of the following correctly expresses Ohm's law?
a. $R = I \times V$
b. $V = I \times R$
c. $I = V \times R$
d. $V = I/R$

ANS: B
The relationships among current, voltage, and resistance can be explained with Ohm's law: $V = I \times R$.

PTS: 1 REF: Page 19

103. According to Ohm's law, assuming that the voltage is held constant, what will happen to the resistance if the current is doubled?
a. It will remain the same.
b. It will be doubled.
c. It will quadruple.
d. It will be halved.

ANS: D
Given the fact that when resistance is constant, there is a direct relationship between voltage and current; when voltage is constant, there is an indirect or inverse relationship between current and resistance. Therefore, if current is increased, resistance would have to decrease proportionately.

PTS: 1 REF: Page 19

104. A major disadvantage of a series circuit is which of the following?
a. It is limited to one load.
b. It can contain unlimited resistance.
c. Electrical current will stop if a break occurs anywhere along the path.
d. The circuit will remain up if a break occurs in one of the branches.

ANS: C
In a series circuit, there is only one path. If a break occurs anywhere in the path, the entire circuit will fail.

PTS: 1 REF: Page 20

105. A series circuit contains a total resistance of 100 Ω. If the circuit has three resistors and one of the resistors is 40 Ω, what is the combined resistance of the last two resistors?
a. 60 Ω
b. 2.5 Ω
c. 140 Ω
d. 0.04 Ω

ANS: A
According to Kirchhoff's laws regarding series circuits, total resistance is equal to the sum of all resistors in the circuit. If the circuit has three resistors, total resistance = A + B + C. Therefore, 100 = A + B + C. If one resistor is 40 Ω, then 100 = 40 + B + C and the sum of B + C must equal 60 Ω.

PTS: 1 REF: Page 20

106. Which organ in the human body is most susceptible to electrical shock?
a. Skin
b. Heart
c. Brain
d. Lungs

ANS: B
Although all body tissues and organs are susceptible to electrical shock, the heart is the most vulnerable because it is governed by electricity.

PTS: 1 REF: Pages 20-21

107. Electrical hazards can be prevented by which of the following?
1. Properly grounding the circuit
2. Using ground fault circuit interrupters (GFCIs)
3. Using only Underwriters Laboratories (UL)–approved electrical equipment
4. Using as many extension cords as necessary to keep the wires out of the way
a. 1 and 2
b. 3 and 4
c. 2 and 3
d. 1, 2, and 3

ANS: D
Grounding provides a path of least resistance that allows current to bypass the body in the event of a short circuit. GFCIs are circuit breakers that will trip when there is even a small difference between current flowing out through the device and current returning through the device. UL certifies devices that are plugged into current sources.

PTS: 1 REF: Page 21

108. If 50% of the gas delivered to a patient is oxygen, its partial pressure at 1 atm is _____ mm Hg.
a. 265.0
b. 356.5
c. 380.0
d. 403.5

ANS: C
The partial pressure of a gas in a mixture can be calculated by multiplying the total pressure of the mixture by the percentage of the mixture that the gas in question occupies. Therefore, 0.5×760 mm Hg = 380 mm Hg.

PTS: 1 REF: Page 14

109. The standard unit of measurement for voltage is
a. milliampere.
b. coulomb.
c. ampere.
d. volt.

ANS: D
Voltage is measured using a voltmeter; the standard unit of measurement for voltage is the volt (V), which can be defined as the electrical potential required for 1A of electricity to move through 1 ohm (Ω) of resistance. As with amperes, volts can be subdivided into smaller units, such as millivolts (mV) and microvolts (μV).

PTS: 1 REF: Page 20

110. Which of the following is a series-parallel circuit that consists of a direct current (DC) voltage source and a galvanometer that connects two parallel branches containing four resistors?
a. Hunter Christie bridge
b. Wheatstone bridge
c. Transducer
d. Circuit analysis

ANS: B
The Wheatstone bridge is a series-parallel circuit that consists of a DC voltage source (e.g., a battery) and a galvanometer that connects two parallel branches containing four resistors (R_1, R_2, R_3, and R_X).

PTS: 1 REF: Page 20

111. Which of the following devices are used to measure atmospheric pressure?

1. Aneroid barometer
2. Wheatstone Bridge
3. Mercury barometer
4. Hygrometer

a. 1 and 2
b. 1 and 3
c. 2 and 3
d. 3 and 4

ANS: B
Atmospheric pressure can be measured with a barometer. The aneroid barometer (Fig. 1.5) measures atmospheric pressure by equilibrating the atmospheric gas pressure with a mechanical force, or the expansion force of an evacuated metal container. Atmospheric pressure can be measured with a barometer similar to the one shown in Fig. 1.4. The mercury barometer, which was invented by Evangelista Torricelli (c. 1608-1647), is the most commonly used device for measuring atmospheric pressure. (Torricelli was the first person to recognize the existence of atmospheric pressure; the pressure measurement *torr* is named in his honor.)

PTS: 1 REF: Pages 9-10