# Chapter 01: Basic Physics for the Respiratory Therapist

**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 8

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 8

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

   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. Kinetic energy is energy an object possesses when it is in motion.

   PTS: 1 REF: Page 8

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 8

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 8

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

   ANS: B
   Kinetic energy 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 9

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

   ANS: A
   Kinetic energy = $\frac{1}{2}$(mass of object $\times$ square of velocity it is traveling, or $mv^2$) or KE = $\frac{1}{2}$(V $\times$ V). If the velocity is reduced by half, then KE = $\frac{1}{2}(\frac{1}{2}V \times \frac{1}{2}V)$, or $\frac{1}{2}(\frac{1}{4}) = \frac{1}{8}$ reduction.

   PTS: 1 REF: Page 10

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 kinetic energy or potential energy. Chemical potential energy often refers to the bonds in petroleum oils that, if broken, can be converted to kinetic energy.

   PTS: 1 REF: Page 10

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 10

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 8

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
    Kinetic energy is the energy an object possesses while in motion.

    PTS: 1 REF: Page 9

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 10

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 10

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 11

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

    ANS: D
    Glass and margarine are always considered amorphous solids. Plastic usually shows flexibility, which implies that it has amorphous features, so it should be considered amorphous. Iron, however, has well-organized atoms in a crystalline arrangement.

    PTS: 1 REF: Page 10

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 10

17. The least amount of kinetic energy 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 kinetic energy. The bonds holding their atoms together limit the mobility of the particles that make up the solid.

    PTS: 1 REF: Page 11

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 11

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 11

20. A cylinder of compressed gas contains 1500 psig at 70° F; the cylinder is heated to 120° F. Which of the following effects will occur as a result of the temperature change?
    1. There will be increased kinetic activity in the contents of the cylinder
    2. The volume of gas in the cylinder will increase
    3. The pressure indicated on the pressure gauge will increase.
    a. 1 only
    b. 1 and 2
    c. 1 and 3
    d. 2 and 3

    ANS: C
    The increased temperature will increase the kinetic activity of the molecules which make up the gas. Charles law states that pressure and temperature are directly proportional. An increase in temperature will increase the pressure.

    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 13

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 13

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 15

24. Which two of the following are ways to enhance the process 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: B
    Either decreasing the temperature or increasing the atmospheric pressure will decrease the evaporation rate.

    PTS: 1 REF: Page 16

 

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 18

26. The point at which the vapor pressure of a liquid equals atmospheric pressure 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 19

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 19

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 14

29. Which two of the following are considered vapors?
    1. Carbon dioxide
    2. Nitrogen
    3. Oxygen
    4. Water

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

    ANS: B
    A vapor is the gaseous form of any substance that can exist as a solid or a liquid at ordinary temperature and pressure. Water and dry ice ($CO_2$) can exist as a liquid or a solid at room temperature; $N_2$ and $O_2$ cannot.

    PTS: 1 REF: Page 16

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 24

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 24

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

    ANS: D
    See Figure 1-3 in the textbook.

    PTS: 1 REF: Page 24

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 24

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 24

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 24

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 24

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 24

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 24

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 27

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 27

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 24

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 28

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 29

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

    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 30

45. Properties of a viscous liquid are:
    1. Increased cohesive forces between its molecules
    2. Low density
    3. High density
    4. Free flow
    a. 1 and 3
    b. 1, 2, and 4
    c. 2 and 4
    d. 3 and 4

    ANS: A
    Viscosity is influenced by the strength of the cohesive forces between the molecules and an object's density.

    PTS: 1 REF: Page 31

46. Which of the following is least viscous?
    a. Plastic
    b. Gelatin (e.g., Jell-O)
    c. Metal
    d. Glass

    ANS: B
    Plastic, metal, and glass have cohesive forces between the molecules that are strong enough to prevent any movement under normal circumstances. Jell-O's viscosity will increase with low temperatures and decrease as temperature rises.

    PTS: 1 REF: Page 32

 

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 30

48. Viscosity has an influence on which of the following?
1. Laminar flow
2. Fluid mechanics
3. Sedimentary rate
4. Streamlined flow

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

ANS: D
Viscosity is an important factor to consider in conjunction with laminar flow, streamlined flow, and fluid mechanics.

PTS: 1 REF: Page 31

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 31

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 31

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 32

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 33

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 33

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 33

 

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 34

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 Figure 1-9.

    PTS: 1 REF: Page 34

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. 4
    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 28

 

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 29

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 28

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 35

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 Figure 1-10.

    PTS: 1 REF: Page 13

 

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 35

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 35

64. Which of the following formulas represents Gay-Lussac's law?
    a. $P_1/T_1 = T_2/P_2$
    b. $P_1T_1 = P_2T_2$
    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 35

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 35

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: when the pressure of a gas is held constant, the volume of a gas varies directly with its absolute temperature, which is expressed in Kelvin.

    PTS: 1 REF: Page 36

 

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 36

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 37

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 38

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 38

 

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 par-tial 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 39

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 39

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 39

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 39

 

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 39

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

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

    PTS: 1 REF: Page 40

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 40

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 41

 

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 42

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 43

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 Figure 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: Page 43

 

83. Which of the following formula(s) best represent(s) Graham's law?

I. $c \propto P \times S$

II. $\frac{r_1}{r_2} = \sqrt{\frac{d_1}{d_2}}$

III. $D = S \div \sqrt{MW}$

IV. $\frac{r_1}{r_2} = \sqrt{\frac{M_1}{M_2}}$

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 $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$, 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 $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}}$ 2, where $d_1$ and $d_2$ are the densities of the gases in question.

PTS: 1 REF: Page 43

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 44

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 44

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 37

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 46

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 46

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 46

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 Figure 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 47

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 47

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 48

93. When you discuss the mechanics of breathing, which expression of Poiseuille's law do you use?

a. $P = \dot{Q} \times R$
c. $\dot{V} = P \div R$
b. $\dot{Q} = P \div R$
d. $\dot{Q} = 1/V$

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: Pages 47-48

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 $NR = v \times d \times (2r/\eta)$, where *v* is the velocity of the flow; *r* is the radius of the tube, and *d* and $\eta$ are the density and viscosity of the gas, respectively.

PTS: 1 REF: Page 49

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
c. Bernoulli principle
b. Venturi principle
d. Reynolds' number

ANS: D
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° 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: Page 49

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: Page 49

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 50

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 51

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 52

 

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. 1, 2, 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 52

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 1A is equivalent to $6.25 \times 10^{18}$ electrons passing a point in 1 second. The term *coulomb* is used as a shorthand notation for $6.25 \times 10^{18}$ electrons. The standard unit of measurement for voltage is the *volt* (V). A milliampere is equal to 0.001 A.

PTS: 1 REF: Page 52

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 53

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 53

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 54

105. A series circuit contains a total resistance of 100Ω. 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: Pages 54-55

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: Page 48

 

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. Ground fault circuit interrupters 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. Underwriters Laboratories certifies devices that are plugged into current sources.

PTS: 1 REF: Page 57

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, $0.5 \times 760$ mm Hg = 380 mm Hg.

PTS: 1 REF: Page 16