Chapter 1: Matter and Energy—An Atomic Perspective

LEARNING OBJECTIVES

Describe what is meant by the term *scientific theory* and distinguish it from *natural philosophy.*

Distinguish between elements and compounds.

Describe the scientific method and define a law, a theory, and a hypothesis.

Describe the law of definite proportions.

Describe the law of constant composition.

Describe the law of multiple proportions.

Write chemical formulas from the ratios of the elements in a compound.

Describe and apply the COAST method.

Distinguish between pure substances and mixtures.

Define matter and mass.

Describe and give examples of extensive and intensive properties.

Describe and give examples of chemical and physical properties.

Use density in calculations.

Distinguish between molecules and ions.

Distinguish between physical and chemical changes.

Distinguish between homogeneous and heterogeneous mixtures.

Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography.

Distinguish between the states of matter: solid, liquid, and gas.

Describe how temperature affects the properties of matter.

Describe the processes of sublimation, melting, vaporization, condensation, freezing, and deposition.

Define energy, work, and heat.

Distinguish between potential and kinetic energy.

State the law of conservation of energy.

Recognize and interpret the different ways of representing molecules (diatomic, molecular formula, structural formula, condensed structural formula, ball-and-stick, space-filling).

Describe ionic compounds and identify an empirical formula.

Describe SI and US measurements.

Distinguish between exact and uncertain values.

Distinguish between precision and accuracy.

Apply the rules for significant figures (weak-link principle).

Use the unit-factor method to convert measurements.

Distinguish between and convert Fahrenheit, Celsius, and Kelvin temperatures.

Describe the function of a control sample.

For a data set, calculate the mean, standard deviation, and confidence interval.

Use Grubb's test to determine if a data point is an outlier.

MULTIPLE CHOICE

1. Which step is NOT a part of the scientific method?
   a. Form a testable hypothesis.
   b. Make observations.
   c. Conduct reproducible experiments.
   d. Identify different factors that affect results.
   e. Stop experimentation once the desired results are achieved.

   ANS: E DIF: Easy REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Remembering

2. For a hypothesis to be considered a valid scientific theory, it must _____
   a. summarize experimental data without trying to predict future results.
   b. be impossible to prove wrong by experiment.
   c. explain widely observed phenomena based on extensive testing.
   d. never be modified or expanded.
   e. be voted on by the scientific community and accepted by all.

   ANS: C DIF: Easy REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Understanding

3. According to the law of definite proportions, _____
   a. atoms forming a given compound react in variable proportions depending on conditions.
   b. different samples of the same compound contain the same proportions of the same elements.
   c. all compounds containing the same types of atoms have identical properties.
   d. all compounds containing the same types of atoms have relative masses that are whole-number multiples.
   e. only one type of molecule can be produced when two elements combine.

   ANS: B DIF: Easy REF: 1.1
   OBJ: Describe the law of definite proportions. MSC: Understanding

4. The law of definite proportions states that _____
   a. compounds such as NO and NO_2 have identical chemical properties.
   b. compounds such as NO and NO_2 must have masses that are whole-number multiples of each other.
   c. nitrogen and oxygen can combine to form a variety of compounds, such as NO or NO_2.
   d. the elements forming a given compound always react in the same proportions.
   e. only one compound can be produced when two elements combine.

   ANS: D DIF: Easy REF: 1.1
   OBJ: Describe the law of definite proportions. MSC: Understanding

5. Which one of the following is a hypothesis?
   a. Energy is required to vaporize a liquid.
   b. The composition of a pure substance is fixed and definite.
   c. Hydrogen gas and oxygen gas can react to form water.
   d. A Car's battery must be dead because the car won't start.
   e. Matter is composed of atoms.

   ANS: D DIF: Moderate REF: 1.1
   OBJ: Describe the scientific method and define a law, a theory, and a hypothesis.
   MSC: Applying

6. Which of the following illustrates the law of multiple proportions?
   a. The mass ratio of O to N in NO_2 is twice that in NO.
   b. NO_2 always contains one nitrogen atom and two oxygen atoms.
   c. The mass of NO_2 is a small whole-number multiple of the mass of NO.
   d. NO and NO_2 have similar chemical and physical properties.
   e. NO_2 and N_2O_4 are the same compound.

   ANS: A DIF: Moderate REF: 1.1
   OBJ: Describe the law of multiple proportions. MSC: Understanding

7. Which of the following does NOT illustrate the law of multiple proportions?
   a. The N-to-O mass ratio in NO is 0.875, whereas that in N_2O is 1.75.
   b. C_2H_2 has a 12:1 C-to-H mass ratio, while C_2H_6 has a 4:1 C-to-H mass ratio.
   c. The ratio of O:C by mass in CO_2 is twice that of CO.
   d. If a sample of H_2O contains 16 g of oxygen, a sample of H_2O_2 with the same number of molecules would contain 32 g of oxygen.
   e. H_2S and H_2O contain the same mass of hydrogen.

   ANS: E DIF: Difficult REF: 1.1
   OBJ: Describe the law of multiple proportions. MSC: Applying

8. Which of the following statements is NOT true?
   a. The relative numbers of each type of atom in a given compound do not vary.
   b. A compound always contains the same mass percentages of its constituent elements.
   c. A large sample and a small sample of a given compound contain the same number of each type of atom.
   d. A large sample and a small sample of a given compound contain the same types of atoms combined in the same proportions.
   e. A large sample and a small sample of a compound share the same chemical formula.

   ANS: C DIF: Difficult REF: 1.1
   OBJ: Describe the law of constant composition. MSC: Analyzing

9. Which of the following statements is NOT true?
   a. Given that the chemical formula of methanol is CH_4O, the number of carbon atoms in a sample of methanol will be the same as the number of oxygen atoms.
   b. If a compound is 75% carbon and 25% hydrogen by mass, 12 g of the compound contains 9 g C and 3 g H.
   c. If a compound contains 76 g of chlorine and 12 g of carbon, it will always have a 6.33:1 mass ratio of Cl to C.
   d. A compound containing 17.1 g of phosphorus and 58.9 g of chlorine has the same identity as a compound containing 35.7 g P and 204.3 g Cl.
   e. A compound containing 106.6 g of copper and 13.4 g of oxygen has the same identity as a compound containing 159.9 g Cu and 20.1 g O.

   ANS: D DIF: Difficult REF: 1.1
   OBJ: Describe the law of constant composition. MSC: Evaluating

10. A pure substance _____
   a. must be composed of atoms of the same type.
   b. cannot be separated into simpler substances by physical means.
   c. must be a compound.
   d. has different chemical properties depending on its source.
   e. can have a composition that varies from sample to sample.

   ANS: B DIF: Easy REF: 1.3
   OBJ: Distinguish between pure substances and mixtures. MSC: Remembering

11. Which of the following is NOT a pure substance?
   a. sparkling water
   b. gold metal
   c. oxygen gas
   d. water vapor
   e. dry ice (solid CO_2)

   ANS: A DIF: Easy REF: 1.3
   OBJ: Distinguish between pure substances and mixtures. MSC: Understanding

12. Which of the following is a pure substance?
   a. seawater
   b. blood
   c. brass (an alloy of copper and zinc)
   d. table sugar(sucrose, $C_{12}H_{22}O_{11}$)
   e. beer

   ANS: D DIF: Easy REF: 1.3
   OBJ: Distinguish between pure substances and mixtures. MSC: Understanding

13. A molecule _____
   a. must contain at least two types of atoms.
   b. can be an element or a compound.
   c. cannot form a solid.
   d. cannot be broken into its constituent atoms by any means.
   e. can contain only one type of atom.

   ANS: B DIF: Easy REF: 1.3
   OBJ: Distinguish between elements and compounds. MSC: Remembering

14. A sample of a compound _____
    a. breaks into its constituent atoms during phase changes.
    b. is a homogeneous mixture.
    c. contains atoms that can be physically separated from each other.
    d. contains at least two types of atoms in a constant, fixed ratio.
    e. has a variable composition depending on its temperature.

    ANS: D DIF: Easy REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Remembering

15. Which of the following is an element?
    a. $C_6H_{12}O_6$
    b. HNO_3
    c. NaCl
    d. CH_4
    e. O_3

    ANS: E DIF: Easy REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Understanding

16. Which of the following is NOT an element?
    a. Cs
    b. Au
    c. CS_2
    d. Ar
    e. Co

    ANS: C DIF: Easy REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Understanding

17. An element _____
    a. can be separated into its components by physical methods.
    b. has different chemical properties depending on its state.
    c. cannot be separated into simpler substances by chemical methods.
    d. can also be a compound.
    e. exists only as atoms, not as molecules.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Understanding

18. Table sugar (sucrose, $C_{12}H_{22}O_{11}$) dissolves in water. This process _____
    a. is a chemical change.
    b. is a physical change.
    c. produces a heterogeneous mixture.
    d. is a chemical property of sucrose.
    e. converts sucrose to carbon dioxide and water.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Understanding

19. Which of the following is a homogeneous mixture?
    a. an egg
    b. smoke
    c. beach sand
    d. dry ice (solid CO_2)
    e. a salt solution (NaCl dissolved in water)

    ANS: E DIF: Easy REF: 1.3
    OBJ: Distinguish between homogeneous and heterogeneous mixtures.
    MSC: Understanding

20. Which of the following is a heterogeneous mixture?
    a. concrete
    b. sweet tea
    c. black coffee
    d. mercury metal
    e. an intravenous (IV) solution

    ANS: A DIF: Easy REF: 1.3
    OBJ: Distinguish between homogeneous and heterogeneous mixtures.
    MSC: Understanding

21. Distillation may be used to separate components in a mixture based on _____
    a. solubilities.
    b. masses.
    c. volatilities.
    d. densities.
    e. colors.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Remembering

22. Which of the following is a chemical property of formaldehyde (CH_2O)?
    a. It is flammable.
    b. It has a density of 1.09 g/mL.
    c. It is colorless.
    d. It dissolves in water.
    e. It is a gas at room temperature.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

23. Which of the following is a chemical property of copper metal?
    a. It conducts heat.
    b. It reacts with nitric acid to produce copper(II) nitrate.
    c. It melts at 1085°C
    d. It conducts electricity.
    e. It has an orange color.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

24. Which of the following represents a physical property of water?
    a. It boils at 100°C.
    b. An electrical current decomposes water into hydrogen gas and oxygen gas.
    c. It reacts with iron metal and oxygen to form rust.
    d. It reacts with carbon monoxide to form carbon dioxide and hydrogen gas.
    e. It is used in photosynthesis.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

25. Which of the following represents a chemical property of iron?
    a. Its density is 7.84 g/cm^3.
    b. It is magnetic.
    c. It reacts with oxygen in moist air.
    d. Its melting point is 1538°C.
    e. It conducts electricity.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

26. Which of the following is a chemical property of acetone (C_3H_6O)?
    a. It readily evaporates at room temperature.
    b. It has a pungent, irritating odor.
    c. It can be ignited in oxygen.
    d. It boils at 56°C.
    e. It is miscible with water.

    ANS: C DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

27. Which of the following is a chemical property of platinum?
    a. It conducts heat and electricity.
    b. It can react with chlorine gas to form platinum(IV) chloride.
    c. The difference between its melting and boiling points is 2057°C.
    d. It is a gray-white metal.
    e. Sound travels through it at a speed of 2680 m/s.

    ANS: B DIF: Easy REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Remembering

28. Extensive properties are _____
    a. dependent on the amount of substance present.
    b. identical for all substances.
    c. independent of a substance's phase.
    d. the physical properties of a substance.
    e. dependent on the reactivity of the substance.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Remembering

29. Which one of the following represents a physical change?
    a. Milk turns sour.
    b. Rust forms on iron nails.
    c. Sugar ferments to form ethanol.
    d. An egg begins to smell very bad.
    e. Sugar melts and forms a syrupy liquid.

    ANS: E DIF: Easy REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Understanding

30. Which one of the following represents a chemical change?
    a. Mercury(II) oxide is heated up and forms mercury metal and oxygen gas.
    b. Rubbing alcohol evaporates.
    c. Iodine vapor deposits on a surface.
    d. Iron metal is separated from sand using a magnet.
    e. Rock salt is pulverized.

    ANS: A DIF: Easy REF: 1.3
    OBJ: Distinguish between physical and chemical changes. MSC: Understanding

31. Which one of the following is NOT an intensive physical property of a pure liquid?
    a. boiling point
    b. conductivity
    c. mass
    d. density
    e. color

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Remembering

32. Which statement is true regarding ammonia, NH_3?
    a. It can also be correctly represented as N_2H_6.
    b. It cannot be decomposed into simpler substances by any means.
    c. Its decomposition produces three volumes of hydrogen for every one volume of nitrogen.
    d. It can be separated into nitrogen and hydrogen atoms using distillation.
    e. It is not a stable molecule and does not exist at room temperature.

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Distinguish between elements and compounds. MSC: Understanding

33. When copper metal is dropped into nitric acid, a blue solution containing copper(II) ions is produced along with brown nitrogen monoxide gas. Which of the following is an example of a chemical property?
    a. copper's red-orange appearance
    b. nitrogen monoxide's irritating odor
    c. the blue color of aqueous copper(II) ions
    d. the viscosity of nitric acid at room temperature
    e. nitric acid's ability to react with copper metal

    ANS: E DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of chemical and physical properties.
    MSC: Analyzing

34. If you had equal masses of each of the following substances, which would occupy the greatest volume?
    a. ice ($d = 0.917$ g/mL)
    b. water ($d = 0.997$ g/mL)
    c. beeswax ($d = 0.960$ g/mL)
    d. cocoa butter ($d = 0.910$ g/mL)
    e. aluminum ($d = 2.70$ g/mL)

    ANS: D DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
    MSC: Analyzing

35. The densities of glycerol and of mercury are 1.26 g/mL and 13.5 g/mL, respectively. What volume of glycerol has the same mass as 25.0 mL of mercury?
    a. 268 mL
    b. 426 mL
    c. 2.33 mL
    d. 1.47 mL
    e. 338 mL

    ANS: A DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
    MSC: Applying

36. Based on values for the volume per gram of the given materials, which of the following would NOT float in water (density = 0.997 g/cm^3)?

Substance	**g/cm^3**
Balsa wood	0.120
Cork	0.240
Charcoal (from oak)	0.571
Human fat	0.943
Ethylene glycol	1.11

    a. balsa wood
    b. cork
    c. charcoal
    d. human fat
    e. ethylene glycol

    ANS: E DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
    MSC: Applying

37. Calcite has a chemical formula of $CaCO_3$, and 1.0 g occupies approximately 0.369 cm^3. Pyrite (FeS_2) is 1.8 times denser than calcite. What is the density of FeS_2?
    a. 2.7 g/cm^3
    b. 0.66 g/cm^3
    c. 4.9 g/cm^3
    d. 2.2 g/cm^3
    e. 1.5 g/cm^3

    ANS: C DIF: Moderate REF: 1.3 OBJ: Use density in calculations.
    MSC: Applying

38. Which of the following can be separated by filtration?
    a. rust particles in water
    b. air dispersed in whipped cream
    c. alcohol dissolved in water
    d. salt dissolved in water
    e. nitrogen from air

    ANS: A DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Understanding

39. Which process would be a practical and effective way to separate beta-carotene, an orange pigment, from hexane liquid?
    a. filtration
    b. chromatography
    c. combustion
    d. scanning tunneling microscopy
    e. sublimation

    ANS: B DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Applying

40. Acetone and water mix to form a homogeneous solution. Acetone has a boiling point of 56°C. Which of the following would be a suitable method for separating acetone from water?
    a. filtration
    b. combustion
    c. distillation
    d. scanning tunneling microscopy
    e. sublimation

    ANS: C DIF: Moderate REF: 1.3
    OBJ: Describe the methods that can be used to separate the components of a mixture: distillation, filtration, and chromatography. MSC: Applying

41. Which of the following is an intensive property of chlorine?
    a. It has mass.
    b. It boils at –34°C.
    c. Chlorine gas expands to fill a balloon.
    d. The reaction of chlorine with hydrogen releases a given amount of energy.
    e. Chlorine gas in a container exerts a given pressure at a given temperature.

    ANS: B DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Analyzing

42. Which represents an extensive property of hydrogen?
    a. Hydrogen gas is odorless and colorless.
    b. A hydrogen gas molecule is composed of two hydrogen atoms.
    c. Hydrogen gas is flammable.
    d. Hydrogen releases a given amount of energy when it reacts with oxygen.
    e. Hydrogen gas under normal conditions is nonmetallic.

    ANS: D DIF: Moderate REF: 1.3
    OBJ: Describe and give examples of extensive and intensive properties.
    MSC: Analyzing

43. The densities of cork, lead, and water are 0.240 g/cm^3, 11.34 g/cm^3, and 0.997 g/cm^3 at 25°C, respectively. If 20.0 g of lead are placed inside an 85.0 cm^3 piece of cork, what is the overall density, and will it float on water?
    a. 0.466 g/cm^3; Yes, it will float.
    b. 0.235 g/cm^3; Yes, it will float.
    c. 0.211 g/cm^3; Yes, it will float.
    d. 4.25 g/cm^3; No, it will not float.
    e. 2.15 g/cm^3; No, it will not float.

    ANS: A DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
    MSC: Applying

44. Soft solder is a blended alloy of tin (7.31 g/cm^3) and lead (11.34 g/cm^3) that is used in plumbing and electronics. It is 63.5% tin by mass. What is the density of the alloy?
    a. 9.87 g/cm^3
    b. 8.27 g/cm^3
    c. 7.83 g/cm^3
    d. 8.79 g/cm^3
    e. 9.33 g/cm^3

    ANS: D DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
    MSC: Evaluating

45. Gold (19.3 g/cm^3) and copper (8.96 g/cm^3) can be blended to form an alloy called rose gold. Suppose a rose-gold bar has a mass of 117 g and a volume of 7.00 cm^3. Calculate the mass percentage of gold in the bar.
    a. 46.4%
    b. 53.6%
    c. 38.7%
    d. 75.0%
    e. 86.6%

    ANS: D DIF: Difficult REF: 1.3 OBJ: Use density in calculations.
    MSC: Evaluating

46. Which statement correctly describes the properties of gaseous helium (He)?
    a. The gas is not highly compressible even though the atoms do not occupy the entire volume of the container.
    b. The gas is highly compressible because there is a lot of empty space between the atoms.
    c. The atoms are moving rapidly about the container, giving the gas its definite shape.
    d. The gas has a definite volume and shape because the atoms are not moving about the container.
    e. A gas takes the shape of the container, but its total volume cannot change.

    ANS: B DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Remembering

47. Solid carbon dioxide (CO_2) can undergo sublimation to form gaseous CO_2. Which of the following statements is true?
    a. In the solid phase, CO_2 molecules easily slip past each other, and there are areas of randomly ordered molecules.
    b. In the gas phase, CO_2 molecules are strongly attracted to each other.
    c. The motion of the CO_2 molecules in the solid phase is much more restricted than in the gas phase.
    d. CO_2 molecules in the solid phase are easily compressed to smaller volumes.
    e. The CO_2 molecules decompose to form carbon and oxygen when they enter the gas phase.

    ANS: C DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Understanding

48. Which statement describing the properties of the different phases of a sample of matter is true?
    a. The particles in both the gas and liquid phases are highly ordered and in close proximity to one another.
    b. The particles in the liquid phase are highly compressible because they can slip past one another.
    c. The particles in both the solid and liquid phases are free to assume any shape, and their nearest neighbors change over time.
    d. The solid phase is rigid, even though its constituent particles may vibrate a little depending on their temperature.
    e. Localized areas of order can form in the gas phase because the particles experience significant attractions to one another.

    ANS: D DIF: Easy REF: 1.4
    OBJ: Distinguish between the states of matter: solid, liquid, and gas.
    MSC: Remembering

49. Equal amounts of water undergo the following changes. Which of the following would involve the largest change in energy?
    a. Ice is melted to form liquid water at 0°C.
    b. Ice at –25°C is heated to 0°C.
    c. Water is heated from 25°C to 50°C.
    d. Steam at 100°C is cooled and condensed to form liquid water at 85°C.
    e. Water at 0°C is heated and vaporized to form steam at 120°C.

    ANS: E DIF: Moderate REF: 1.4
    OBJ: Describe how temperature affects the properties of matter.
    MSC: Analyzing

50. Equal amounts of a pure substance undergo the following changes. Which process would you predict releases the greatest amount of energy?
    a. deposition (gas → solid)
    b. vaporization (liquid → gas)
    c. freezing (liquid → solid)
    d. condensation (gas → liquid)
    e. melting (solid → liquid)

    ANS: A DIF: Moderate REF: 1.4
    OBJ: Describe the processes of sublimation, melting, vaporization, condensation, freezing, and deposition. MSC: Analyzing

51. Which of the following is an example of potential energy?
    a. water running down a hill
    b. chemical bonds in table sugar (sucrose)
    c. electrons flowing through a wire
    d. a crowd moving a barricade
    e. molecules moving randomly in a liquid

    ANS: B DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Understanding

52. Equal amounts of water are present under the following conditions. In which case do the water molecules have the highest kinetic energy?
    a. as ice at –10°C
    b. as steam at 100°C
    c. in the liquid phase at 80°C
    d. in the gas phase at 150°C
    e. in the solid phase at 0°C

    ANS: D DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Understanding

53. If the speed of an object triples, its kinetic energy _____
    a. increases by a factor of 3.
    b. increases by a factor of 9.
    c. decreases by a factor of 3.
    d. decreases by a factor of 9.
    e. is unaffected.

    ANS: B DIF: Easy REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Applying

54. Which of the following statements about energy, work, and heat is NOT true?
    a. Adding heat to a sample of matter increases the average kinetic energy of its constituent particles.
    b. Thermal energy is the portion of the energy of an object that increases as temperature increases.
    c. When an object does work, part of the energy it expends is destroyed as it converts to heat.
    d. The energy available from some chemical reactions can be used to do work and/or produce heat.
    e. Heat involves the transfer of energy from a hotter object to a cooler one.

    ANS: C DIF: Moderate REF: 1.5
    OBJ: Define energy, work, and heat. MSC: Analyzing

55. Consider electrons traveling through a copper (Cu) wire at a speed of 0.024 cm/s. What is true about the energy of their motion?
    a. It is primarily kinetic.
    b. It is primarily potential.
    c. It would be unaffected if the speed of the electrons increased.
    d. It is strongly affected by gravity.
    e. It cannot be used to do work.

    ANS: A DIF: Moderate REF: 1.5
    OBJ: Distinguish between potential and kinetic energy. MSC: Applying