CHAPTER 3

Matter

CHAPTER ANSWERS

1. mass
2. forces
3. gases
4. liquids
5. In solids, the particles are essentially fixed in position relative to one another and can vibrate only in place. In liquids, the particles are still in close proximity to one another, but are able to move in three dimensions relative to one another. In gases, the particles are *not* in close proximity to each other and move freely and independently of one another.
6. gaseous
7. Liquids and gases both have no rigid shape and take on the shape of their containers (because the molecules in them are free to move relative to each other). Liquids are essentially incompressible whereas gases are readily compressible.
8. The stronger the interparticle forces, the more rigid is the sample overall.
9. The gaseous 10-g sample of water has a much *larger* volume than either the solid or liquid samples. Although the 10-g sample of water vapor contains the same amount of water as the solid and liquid sample (the same number of water molecules), there is a great deal of empty space in the gaseous sample.
10. Gases are easily compressed into smaller volumes whereas solids and liquids are not. Because a gaseous sample consists mostly of empty space, it is the empty space that is compressed when pressure is applied to a gas.
11. These are all physical properties.
12. This is a chemical change; the mercury disappears and is replaced by an orange solid.
13. Magnesium burns in air.
14. Magnesium is malleable and ductile.
15. The answer will depend on the students' examples.
16. The most common physical changes are changes in state: solid to liquid, liquid to gaseous, solid to gaseous (and their opposites).
17.
    a. physical: This represents only a change in state.
    b. chemical: When the alcohol in the brandy burns, it is converted into other substances (carbon dioxide and water).
    c. chemical: The acid reacts with the glass and converts it into other substances.

d. physical: This represents only a change in freezing point.

e. chemical: Because the antacid produces a new substance (carbon dioxide), this can be only a chemical change

f. chemical: The metal case of the battery is converted into other substances, which allows the battery to leak.

g. chemical: The cellulose that makes up the cotton fibers is converted into other substances, leaving a hole.

h. physical: Milk contains protein, and when the vinegar is added, the acidity of the vinegar causes a change in the protein's shape that makes it insoluble in water.

i. physical: When you stop pulling on the rubber, it goes back to its original shape.

j. physical: This represents only a change in state.

k. physical: The acetone dissolves the lacquer in the nail polish, forming a solution (which is not a chemical process).

18.

a. physical: The iron is only being heated.

b. chemical: The sugars in the marshmallow are being reduced to carbon.

c. chemical: Most strips contain a peroxide that decomposes.

d. chemical: The bleach oxidizes dyes in the fabric.

e. physical: Evaporation is only a change of state.

f. physical: The salt is modifying only the physical properties of the solution, not undergoing a chemical reaction.

g. chemical: The drain cleaner breaks bonds in the hair.

h. physical: Students will most likely reply that this is a physical change since the perfume is evaporating; the sensation of smell, however, depends on chemical processes.

i. physical: The sublimation is only a change of state.

j. physical: The wood is only being physically divided into smaller pieces.

k. chemical: The cellulose in the wood is reacting with oxygen gas.

19. An element cannot be broken down into simpler substances by chemical means. Elements are usually found in the combined state.

20. Compounds consist of two or more elements combined together chemically in a fixed composition, no matter what their source may be. For example, water on earth consists of molecules containing one oxygen atom and two hydrogen atoms. Water on Mars (or any other planet) has the same composition.

21. compounds

22. compounds

23. the same

24. Typically, the properties of a compound and the elements that constitute it are very different. Consider the properties of liquid *water* and the hydrogen and oxygen gases from which the water was prepared. Consider the properties of *sodium chloride* (table salt) and the sodium metal and chlorine gas from which it might have been prepared.

25. This would represent a mixture: The magnesium and sulfur have only been placed together in the same container at this point, but no reaction has occurred.

26. Assuming the magnesium and sulfur had been measured out in *exactly the correct ratio for complete reaction*, what would remain after heating would be a pure compound. If there were an *excess* of either magnesium or sulfur, however, the material left after reaction would be a *mixture* of the compound and the excess reagent.

27. The term *homogeneous* in this context means that there are no variations in composition in different areas of the mixture.

28. solutions: window cleaner, shampoo, rubbing alcohol

    mixtures: salad dressing, jelly beans, the change in my pocket

29.

    a. mixture
    b. mixture
    c. pure substance (hopefully)
    d. pure substance

30.

    a. primarily a pure compound, but fillers and anti-caking agents may have been added
    b. mixture
    c. mixture
    d. pure substance

31.

    a. heterogeneous
    b. homogeneous (macroscopically, assuming plain mayonnaise)
    c. heterogeneous
    d. heterogeneous
    e. heterogeneous

32.

    a. homogeneous
    b. heterogeneous
    c. heterogeneous
    d. heterogeneous
    e. homogeneous

33. Consider a salt solution (sodium chloride in water). Since water boils at a much lower temperature than sodium chloride, the water can be boiled off from the solution, collected, and subsequently condensed back into the liquid state. This separates the two chemical substances.

34. Consider a mixture of salt (sodium chloride) and sand. Salt is soluble in water, sand is not. The mixture is added to water, stirred to dissolve the salt and then filtered. The salt solution passes through the filter; the sand remains on the filter. The water can then be evaporated from the salt.

35. If water is added to the sample, and the sample is then heated to boiling, this should dissolve the benzoic acid but not the charcoal. The hot sample could then be *filtered*, which would remove the charcoal. The solution that passed through the filter could then be cooled. This should cause some of the benzoic acid to crystallize, or the solution could be heated carefully to boil off the water and leave benzoic acid behind.

36. The solution is heated to vaporize (boil) the water. The water vapor is then cooled so that it condenses back to the liquid state, and the liquid is collected. After all the water is vaporized from the original sample, pure sodium chloride will remain. The process consists of physical changes.

37. mixture, compound

38. Since *X* is a pure substance, the fact that two different solids form when electrical current is passed indicates that *X* must be a compound.

39. Chalk must be a compound, as it loses mass when heated and appears to change into a substance with different physical properties (the hard chalk turns into a crumbly substance).

40. Because vaporized water is still the *same substance* as solid water, no chemical reaction has occurred. Sublimation is a physical change.

41. Liquids and gases both flow freely and take on the shape of their container. The molecules in liquids are relatively close together and interact with each other, whereas the molecules in gases are far apart from each other and do not interact with each other.

42. far apart

43. physical

44. chemical

45. physical

46. chemical

47. state

48. electrolysis

49.

    a. physical: Milk contains protein, and when the vinegar is added, the acidity of the vinegar causes a change in the protein's shape, making it insoluble in water (See Chapter 21.).

    b. chemical: Exposure to the oxygen of the air allows bacteria to grow that cause the chemical breakdown of components of the butter.

    c. physical: Salad dressing is a physical mixture of water-soluble and insoluble components that only combine temporarily when the dressing is shaken.

    d. chemical: Milk of magnesia is a *base* that chemically reacts with and neutralizes the acid of the stomach.

e. chemical: Steel consists mostly of iron, which chemically reacts with the oxygen of the atmosphere.

f. chemical: Carbon monoxide combines chemically with the hemoglobin fraction of the blood, making it impossible for the hemoglobin to combine with oxygen.

g. chemical: Cotton consists of the carbohydrate cellulose, which is broken down chemically by acids.

h. physical: Sweat consists mostly of water, which consumes heat from the body in evaporating.

i. chemical: Although the biochemical action of aspirin is not fully understood, the process is chemical in nature.

j. physical: Oil molecules are not water soluble and are repelled by the moisture in skin.

k. chemical: the fact that one substance is converted into two other substances demonstrates that this is a chemical process.

50.

a. heterogeneous

b. heterogeneous

c. heterogeneous (Unless you work hard to get all the lumps out!)

d. Although strictly heterogeneous, it may appear homogeneous.

e. heterogeneous

51.

a. heterogeneous

b. homogeneous

c. heterogeneous

d. homogeneous (assuming there are no imperfections in the glass)

e. heterogeneous

52. Answer depends on student's response

53. Answer depends on student's choices.

54. physical, chemical

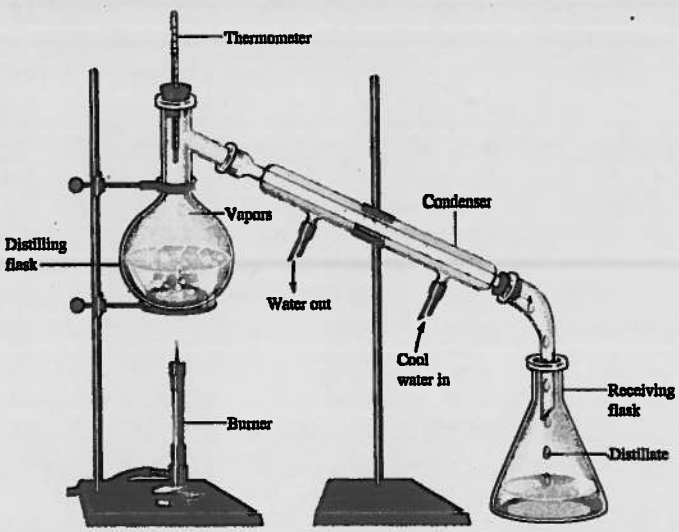
55. d

56. O_2 and P_4 are both still elements, even though the ordinary forms of these elements consist of molecules containing more than one atom (but all atoms in each respective molecule are the same). P_2O_5 is a compound because it is made up of two or more different elements (not all the atoms in the P_2O_5 molecule are the same).

57. Answer depends on student's response.

58. Assuming there is enough water present in the mixture to have dissolved all the salt, filter the mixture to separate out the sand from the mixture. Then distill the filtrate (consisting of salt and water), which will boil off the water, leaving the salt.

59. See Figure 3.6 in the text.



60. The most obvious difference is the physical states: Water is a liquid under room conditions; hydrogen and oxygen are both gases. Hydrogen is flammable. Oxygen supports combustion. Water does neither.