1. Answer will depend on each person's experience.
2. Change
   a. Formation of snowflakes is a physical change because liquid water crystallizes to form solid water; the process can be reversed by melting the snowflake.
   b. Rusting of iron is a chemical change. Iron combines with oxygen to form a new substance.
   c. Ripening of fruit is a chemical change; the numbers of fragrant esters and sugars change.
   d. Fashioning a table from a piece of wood is a physical change; the shape of the piece of wood is mechanically altered.
   e. Fermenting grapes is a chemical change; sugars are converted to alcohol and carbon dioxide.
   f. Boiling a potato is a chemical change; the molecules in the potato are converted to smaller ones that are more easily digested and that taste differently.
3. No, they would be the same substance.
4. Density, melting point, boiling point, odor, color. For example, water has a density of 1 g/cm3, a melting point of 0°C, a boiling point of 100°C, no odor, and no color.
5. This fact illustrates that one chemical can have many different uses depending on its quantity. Utilization of a small amount of nitroglycerin in treating angina outweighs the risks while when used in larger quantities, the risks can be reversed like when it is used as an explosive.
6. Chemical and Physical properties
   a. physical property
   b. physical property
   c. chemical property
   d. physical property
   e. chemical property
   f. chemical property
7. This answer can vary between students, but the combustion of gasoline to propel vehicles is an example of a useful chemical reaction. This reaction is a chemical change because the liquid gasoline is converted to heat and gases. Another constructive example is the burning of coal to heat water into steam, which is then used to turn a turbine and produce electricity.

The combustion of coal results in a flame plus other gases. The above two examples are examples of chemical changes because the products have a different chemical formula than reactants or another way to look at this reaction is that it is not reversible. On the other hand, a destructive reaction is the use of ammonia nitrate to construct bombs for devastation. This compound is a solid but mixed with the correct reactants will produce a flame plus a rapid expansion of gases that makes the explosion. The products formed in this reaction are definitely different than the starting materials.

8. Aggregation
   a. element, contains only Hg atoms
   b. mixture of water, minerals, proteins, fats
   c. compound, contains only one kind of molecule (H_2O)
   d. mixture of cellulose, water. Wood changes weight when dried.
   e. mixture of dye and solvent
   f. mixture of water, caffeine, tea extract
   g. compound, solid pure water containing only one kind of molecule
   h. element, contains only C atoms
   i. element, contains only Sb atoms
9. a. tin: solid
   b. bromine: liquid
   c. dysprosium: solid
   d. xenon: gas
   e. samarium: solid
   f. lithium: solid
   g. mercury: liquid
   h. iodine: solid
10. a. The role of antifreeze is to prevent freezing, and it ceases to function when it is itself frozen. This change of state is a physical change (liquid to solid).
   b. Burning is the process of a material combining chemically with oxygen.
   c. The change observed, where a gas is produced from the combination of a liquid and a solid, is an example of a chemical change.
   d. Ice is the solid form of water. This is an example of a physical change.
   e. Digestion is the process in which food is broken down into nutrients. This requires a chemical change. An example of this would be the conversion of carbohydrates into fat.
11. a. **S−I−Ne**; sulfur−iodine−neon
   b. **Cr−Y**; chromium−yttrium
   c. **V−Ir−U−S**; vanadium−iridium−uranium−sulfur OR **V−I−Ru−S**; vanadium−iodine−ruthenium−sulfur
   d. **Re−Si−S−Ta−N−Ce**; rhenium−silicon−sulfur−tantalum−nitrogen−cerium OR **Re−S−I−S−Ta−N−Ce**; rhenium−sulfur−iodine−sulfur−tantalum−nitrogen−cerium

e. **Cr−Os−Sb−O−W**;chromium−osmium−antimony−oxygen−tungsten OR
Cr−Os−S−B−O−W; chromium–osmium–sulfur–boron–oxygen–tungsten OR
Cr−O−S−Sb−O−W; chromium–oxygen–sulfur–antimony–oxygen–tungsten OR
Cr−O−S−S−B−O−W; chromium–oxygen–sulfur–sulfur–boron–oxygen –tungsten

f. **Fe−Nd−Er**; iron–neodymium–erbium

g. **Ac−Cu−Se**; actinium−copper–selenium OR **Ac−C−U−Se**; actinium–carbon–uranium–selenium

12. answers depend on each student's name.

13. answers depend on student's choice of word

14. a. mendelevium, named for Dmitri Mendeleev, who is credited with the development of the periodic table

b. potassium, named for the source from which it was first identified, potash (plant ashes). The elemental symbol of K is derived from the Latin word *kalium*.

c. californium, a nonnatural element first prepared at the University of California−Berkeley

d. bohrium,named for Neils Bohr, a physicist who contributed to a modern understanding of atomic structure

e. iridium, named because a pure sample of the element is iridescent

f. ytterbium, named for the mineral yttrie from which it was first isolated, near the Swedish village of Ytterbi

g. curium, named for Marie Curie, an early pioneer in understanding radioactivity

15. a. Cu, Co

b. Cu, Cr, Ce

c. W, Ti, Sn

d. Tl, Th

e. N, Ni

f. Carbon, calcium

g. Fe, F

h. N, Ni, Ne

16. Properties of iron do not change because all particles in iron are atoms of iron. Steel is a mixture of iron and other atoms. The type of steel depends on what is added to the iron.

17. False, a molecule is the smallest part of a compound.

18. True

19. False, a molecule is the smallest part of a compound.

20. True

21. A mixture of sand and salt can be separated by adding water to the mixture. The salt will dissolve in the water while the sand will not and settle to the bottom. Filtration of the solution will result in the capture of sand on the filter paper while the dissolved salt will pass through the funnel (filtrate). The sand can be identified because it is not soluble in water and can be recovered by filtering. The salt can be recovered from the filtrate by evaporating the water.

22. Sources of elements

Element	**Major Source**	**Compound**
nitrogen	air	ammonia, NH_3
sulfur	Underground deposits	sulfuric acid, H_2SO_4
chlorine	sea water	sodium chloride, NaC1
magnesium	Milk of Magnesia, sea water	magnesium hydroxide, $Mg(OH)_2$
cobalt	Mineral deposits	cyanocobalamin, Vitamin B_{12}

23. Atrazine, $C_8H_{14}N_5Cl$, contains the elements carbon, hydrogen, nitrogen, chlorine.

24. Cytoxan, $C_7H_{15}O_2N_2PCl_2$
    a. twenty−nine, 29 atoms total
    b. carbon, hydrogen, oxygen, nitrogen, phosphorus, chlorine
    c. 15 hydrogens/2 nitrogen
    d. yes, it is organic

25. Products
    a. BonAmi kitchen and bath cleanser
    b. Coca Cola
    c. Gatorade
    d. Coca Cola
    e. Skippy Peanut Butter
    f. Kraft Grated Parmesan Cheese
    g. Morton's Iodized Salt
    h. Oil of Olay
    i. Mylanta
    j. Kellogg's Frosted Mini−Wheats

26. Materials and Phases

	SOLID	**LIQUID**	GAS
Pure substances	iron, Fe; copper, Cu	octane, C_8H_{18}	dry ice, CO_2 mercury, Hg; helium, He; nitrogen, N_2 , methane, CH_4
Mixtures	Butter, Steel, 14 K "gold"	homogenized fuel (hydro−carbons mixed with mercaptans), milk, coffee, sea water	Natural gas, a person's exhaled breath (CO_2, O_2, H_2O)

27. (c) The identity of the atoms in the reactants has to be the same as the products. The number of atoms on each side of the equation must also be equal.

28. Yes, a mixture of H_2 and O_2 can exist at room temperature. This mixture will be stable as long as no spark or activation energy is added. A reaction produces water, H_2O, which contains both elements.

29. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

30. (d) reactant; products

31. Four kinds of energy

    a. Electrical energy can be generated by chemical reactions used in alkaline batteries and car batteries.

    b. Heat energy can be generated by chemical reactions involving combustion or burning of gasoline.

    c. Light energy can be generated by chemical reactions used by fire flies or in glow sticks.

    d. Mechanical energy can by generated by using water behind a dam to turn a turbine or the alternator on a car using the belt of the engine.

32. Reactions in words

    a. Two sodium atoms react with one chlorine molecule to form two formula units of sodium chloride solid.

    b. One nitrogen molecule reacts with three chlorine molecules to produce two molecules of nitrogen trichloride.

    c. One molecule of carbon dioxide reacts with one molecule of water to produce one molecule of carbonic acid.

    d. (d) Two molecules of hydrogen peroxide react to produce one molecule of oxygen gas and two molecules of water liquid.

33. Balance

    a. On the left side of the arrow, "2 Na" means 2 Na atoms; one Cl_2 molecule contains 2 Cl atoms. On the right side 2 NaCl units contain 2 Na atoms and 2 Cl atoms.

    b. On the left one N_2 molecule contains 2 N atoms and 3 Cl_2 molecules contain 6 Cl atoms. On the right 2 NCl_3 molecules contain a total of 2 N atoms and 6 Cl atoms.

    c. On the left there are 1 C atom, 2 H atoms and 2 + 1 = 3 O atoms. On the right there are 1 C atom, 2 H atoms and 3 O atoms.

    d. On the left there are 4 H atoms and 4 O atoms in 2 molecules of H_2O_2. On the right there are 4 H atoms in the 2 molecules of water; there are also 2 O atoms in the 2 water molecules and 2 more O atoms in the O_2 molecule for a total of 4 O atoms.

34. For (b) the reactants are nitrogen and chlorine; the product is nitrogen trichloride. For (d) the reactant is hydrogen peroxide; the products are water and oxygen.

35. Testing balances

    a. No. The reactant side contains 1 silver atom, 1 nitrogen atom, 1 sulfur atom, 2 sodium atoms and 7 oxygen atoms while the product side contains 2 silver atoms, 1 nitrogen atom, 1 sulfur atom, 1 sodium atom and 7 oxygen atoms.

    b. Yes. The reactant side contains 1 silver atom, 1 nitrogen atom, 1 hydrogen atom, 1 chlorine atom and 3 oxygen atoms while the product side contains 1 silver atom, 1 nitrogen atom, 1 hydrogen atom, 1 chlorine atom and 3 oxygen atoms.

36. a. $2\ K(s) + 2\ H_2O(l) 2\ KOH(s) + H_2(g)$

    b. $CO_2(g) + H_2O(l) H_2CO_3(l)$

37. The tea in tea bags is a mixture. It can be partially separated by dissolving some water−soluble substances with hot water. Instant tea is a mixture of the water− soluble substances in tea.

38. Pure substances in the kitchen

    a. Baking soda contains only sodium bicarbonate molecules

    b. Granulated sugar contains only sucrose molecules

    c. Table salt contains only sodium chloride molecules

    d. An iron skillet contains only iron atoms

    e. Aluminum foil contains only aluminum atoms

    f. Water contains only water molecules

39. Unit conversions

    a. 1 gram = 1000 milligrams

    b. 1 kilometer = 1000 meters

    c. 1 gram = 100 centigrams

40. Mass measured in grams. Length is measured in meters. Volume is measured in liters.

41. Units

    a. 9 cal/g; no

    b. 100 cm/m; no.

    c. 1.5 g/mL; yes, grams/milliliter is mass/volume.

    d. 454 g/lb.; no.

42. Yes, a 2 quart bowl will hold 1.89 L. One liter is 1.06 quarts. One quart equals 0.94 3 liters.

43. 5.5 acres/55 cows

44. The milligrams can be converted to grams using the factor 1000 mg = 1 g.

    $200 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} = 0.200 \text{ grams}$

    The milligrams can be converted to micrograms using the factor 1000 µg = 1 mg. $200 \text{ mg} \times \frac{1000 \text{ µg}}{} = 200{,}000 \text{ µg}$

45. 10 km × (1000 m/1 km) = 10,000 m

46. The answer is 3000 mg protein / 1 oz. cereal

$$\frac{\text{? mg}}{\text{1 oz}} \quad \frac{\text{3.00 g protein}}{\text{1 oz}} \quad \frac{\text{1000 mg}}{\text{1 g}} \quad \frac{\text{3000 mg protein}}{\text{1 oz cereal}}$$

47. Unit conversion

    a. 0.04 m

    b. 43 mg

    c. 15500 mm

    d. 0.328 L(e) 980 g

48. 163 kg (1000 g / 1 kg) = 163,000 g

49. 70 kg (1000 g / 1 kg) = 70,000,000 mg

50. Aspirin

    The milligrams can be converted to grams using the factor 1000 mg = 1 g.

    $325 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} = 0.325 \text{ grams}$

51. (a) $8.0 \quad 10^{7}$ (b) $3.0 \quad 10^{5}$ (c) $1.6 \quad 10^{-5}$ (d) $9.7 \quad 10^{1}$

52. The exponent on "10" can be determined by counting the number of places the decimal point must be moved to the left(+) or the right(−) to give a coefficient *between* 1 and 10. In "a" the decimal point must be moved 6 places to the left so exponent is +6.

a. $8. \times 10^{6}$
b. 7.5×10^{-5}
c. 2.36×10^{10}
d. 3.7×10^{4}
e. 6.492×10^{3}
f. 2.8×10^{-8}

53. Units
    a. 450,000,000 watts
    b. 4,500,000 bulbs
54. The prefix “giga" equals 1,000,000,000 so 60 gigabytes is 60,000,000,000 bytes.
55. 22,420 g
56. Use the definition for density, D = mass/ volume. V = 10 cm × 10 cm × 10 cm = 1000 cm^3.

    Mass = D × V = (11.4 g/cm^3)(1000 cm^3) =11,400 g (or 10,000 rounded to 1 significant digit)
57. The mass of the Al object is 0.34 as much as the mass of the Fe object.
58. 16 fluid ounces
59. 128 fluid ounces
60. 1640 feet
61. 7.73 grains