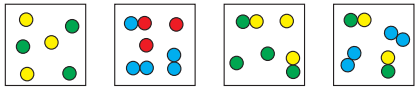
1. Distinguish between a qualitative observation and a quantitative observation. Give two examples of each.

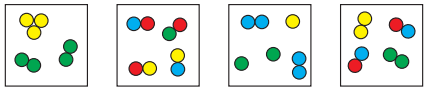
2. Distinguish among the terms element, compound, atom and molecule. Give an example of an element that is a molecule and an example of an element that is an atom.

3. Indicate whether each of the following represents a mixture of atoms, a mixture of molecules, or a mixture of atoms and molecules. Is each a mixture of elements, compounds, or elements and compounds?



(a) **(b)** **(c)** **(d)**

4. Indicate whether each of the following represents a mixture of atoms, a mixture of molecules, or a mixture of atoms and molecules. Is each a mixture of elements, compounds, or elements and compounds?



(a) **(b)** **(c)** **(d)**

5. Classify each of the following as an element or compound:
a) P_4 **b)** Fe **c)** C_3H_6O **d)** SO_2 **e)** O_3

6. Classify each of the following as an element or compound:
a) H_2O **b)** C_{60} **c)** Au **d)** CO **e)** N_2

7. Classify each of the following as an atom or a molecule:
a) P_4 **b)** Fe **c)** C_3H_6O **d)** SO_2 **e)** O_3

8. Classify each of the following as an atom or a molecule:
a) H_2O **b)** C_{60} **c)** Au **d)** CO **e)** N_2

9. Classify each of the following as an atom, molecule, anion, or cation:
a) NH_3 **b)** NH_4^{1+} **c)** N^{3-} **d)** CH_3COO^{1-} **e)** Si

10. Classify each of the following as an atom, molecule, anion, or cation:
a) Na^{1+} **b)** NO_3^{1-} **c)** Na **d)** Cl^{1-} **e)** Al^{3+}

11. Give the name of each of the following elements:
a) Na **b)** Br **c)** Hg **d)** Fe **e)** Ag

12. Give the name of each of the following elements:
a) Pb **b)** Au **c)** F **d)** Ca **e)** P

13. Write the symbol for each of the following elements:
a) copper **b)** lead **c)** strontium **d)** silicon **e)** tin

14. Write the symbol for each of the following elements:
a) potassium **b)** iron **c)** nickel **d)** cadmium **e)** selenium

15. Determine the number of moles of atoms that are present in each of the following samples:
a) 5.0 g K **b)** 17 g Mg **c)** 3.0 g C **d)** 2.2 kg Fe **e)** 14 mg Ag

16. How many moles are in a 5.0-g sample of each of the following elements? How many moles of atoms are in each sample?
a) Ca **b)** F_2 **c)** O_2 **d)** S_8 **e)** P_4.

17. How many moles of molecules are in a 10.0-g sample of each of the following compounds? How many moles of atoms are in each sample?
a) SF_6 **b)** CCl_4 **c)** C_6H_{14} **d)** SO_3 **e)** BF_3

18. Determine the number of moles of carbon that are present in each of the following samples:
a) 1.0 g of aspirin, $C_9H_8O_4$ **b)** 3.0 g of ibuprofen, $C_{13}H_{18}O_2$
c) 12 mg of acetaminophen (Tylenol), $C_8H_9NO_2$

19. Determine the mass of the following samples:
a) 2.5 mol $CaCl_2$ **b)** 0.75 mol C_6H_{12} **c)** 1.8 mol CO_2

20. Determine the mass of the following samples:
a) $4.6x10^{-3}$ mol $Al(NO_3)_3$ **b)** 3.6 mol $C_{12}H_{22}O_{11}$ **c)** 220 mol H_2

21. Consider a 5.00 g sample of Ca_2S_3.
a) How many moles of Ca_2S_3 does it contain?
b) How many moles of sulfur does it contain?
c) How many grams of sulfur does it contain?

22. A sample of $Al(NO_3)_3$ contains 0.90 moles of nitrogen.
a) How many moles of $Al(NO_3)_3$ are present in the sample?
b) What is the mass of the sample in grams?
c) How many moles of oxygen are in the sample?
d) How many aluminum atoms are in the sample?
e) How many grams of aluminum are in the sample?

23. Balance the following equations using the smallest integer coefficients:

a) $N_2 + H_2 \rightarrow NH_3$

b) $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

c) $Al + O_2 \rightarrow Al_2O_3$

d) $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

e) $P_4O_{10} + H_2O \rightarrow H_3PO_4$

f) $Ca + O_2 \rightarrow CaO$

24. Balance the following equations using the smallest integer coefficients:

a) $P_4 + H_2 \rightarrow PH_3$

b) $Cl_2 + O_2 \rightarrow Cl_2O_7$

c) $Al + S_8 \rightarrow Al_2S_3$

b) $H_3PO_4 + KOH \rightarrow K_3PO_4 + H_2O$

e) $N_2O_5 + H_2O \rightarrow HNO_3$

f) $Al + H_2O \rightarrow Al(OH)_3 + H_2$

25. Consider the reaction of 0.30 mol K with O_2, $4K + O_2 \rightarrow 2K_2O$

a) How many moles of molecular oxygen are required?

b) How many moles of potassium oxide would form?

c) What mass, in grams, of potassium oxide would form?

26. Consider the reaction of 6.5 g of iron with O_2, $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

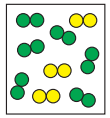
a) How many moles of iron react?

b) How many moles of oxygen must react?

c) How many moles of Fe_2O_3 are formed?

d) What is the mass, in grams, of the Fe_2O_3?

27. The green molecules (G_2) react with the yellow molecules (B_2) to form G_3B as shown to the right. Each circle represents one mole of the atoms. Atomic masses: G = 10 and B = 30.



a) How many grams of G_2 and B_2 are in the container?

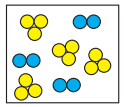
b) How many G_3B molecules can be produced?

c) What is the balanced chemical equation for the reaction?

d) How many grams of G_3B would be produced?

e) What mass of G_2 or B_2 molecules would be left over?

28. The yellow molecules (Y_3) react with the blue molecules (B_2) to form Y_2B as shown to the right. Each circle represents one mole of the atoms. Atomic masses: Y =20 and B = 25.



a) How many grams of Y_3 and B_2 are in the container?

b) How many Y_2B molecules can be produced?

c) What is the balanced chemical equation for the reaction?

d) How many grams of Y_2B would be produced?

e) What mass of Y_3 or B_2 molecules would be left over?

29. Consider the reaction of 6 mol Fe and 6 mol O_2 to produce Fe_3O_4.

a) Write the balanced chemical equation.

b) How many moles of Fe_3O_4 could be produced?

c) How many moles of excess reactant remain after the reaction is done?

30. Consider the reaction of 3 mol P_4 and 10 mol O_2 to produce P_2O_5.

a) Write the balanced chemical equation.

b) How many moles of P_2O_5 could be produced?

c) How many moles of excess reactant remain after the reaction is done?

31. Use Coulomb's law to explain why Na^{1+} ions and Cl^{1-} ions exist as separated ions in liquid water ($\varepsilon = 79$) but form ion pairs (NaCl units) in liquid carbon tetrachloride ($\varepsilon = 2$).

32. Explain what happens to the energy of an electron and a proton as the distance between them decreases. Explain how the energy of two protons changes as the distance between them decreases.

33. What is the charge in coulombs of a mole of electrons?

34. List the following systems of charged particles from most negative to most positive energies of interaction. Also list the forces from most attractive to most repulsive.

a) +2 and -3 charges separated by 10 nm

b) -2 and -1 charges separated by 8 nm

c) -2 and +2 charges separated by 8 nm

35. List the following systems of charged particles from most negative to most positive energies of interaction. Also list the forces from most attractive to most repulsive.

a) +2 and +2 charges separated by 10 nm

b) -2 and +3 charges separated by 11 nm

c) +2 and +1 charges separated by 6 nm

36. Consider Thomson's experiments with cathode rays.

a) What conclusion was drawn because the "rays" were deflected by electric and magnetic fields?

b) What information about the rays was deduced from the fact that the "rays" moved toward the positive plate of the electric field?

c) What two factors dictated the extent of deflection of the rays?

37. Why didn't the oil droplets in Millikan's experiment all have the same charge? What did the charges all have in common?

38. What conclusions did Rutherford draw from the following observations?

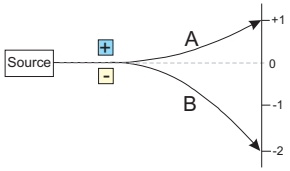
a) Most α-particles passed through the foil with little or no deflection.

b) Some α-particles were deflected at very sharp angles.

c) The fraction of α-particles that was deflected at sharp angles was very small.

39. The deflection of an X^{1+} ion in an electric field is 14% of that of an α-particle. What is the identity of X? An α-particle is $^{4}He^{2+}$.

40. The paths of two particles, A and B, which pass between the plates of an electric field designated by '+' and '-', are shown below. One is a cation with a +1 charge, and the other is an anion with a -1 charge. The line in the center represents the path of an uncharged particle.



a) Identify each particle as an anion or a cation.

b) What is the approximate ratio of the masses of the two particles? Express your answer as the ratio (mass of B)/(mass of A).

41. Use Figure 1.7 and the periodic law to determine the formulas of the oxides of the following elements:

a) phosphorus **b)** arsenic **c)** selenium

d) carbon **e)** cesium

42. Use Figure 1.6 and the periodic nature of the elements to predict which element in each pair has the higher boiling point.

a) Rb or Ca **b)** Si or Sn **c)** C or Pb **d)** Cs or Xe **e)** He or Xe

43. Use periodic behavior and the given chemical formulas to predict the formulas of the compound formed between the following elements:

a) Pb and Cl, given the formulas TlCl and $BiCl_3$

b) Sc and Br, given the formulas KBr and $CaBr_2$

44. Use periodic behavior and the given chemical formulas to predict the formulas of the compound formed between the following elements:

a) Al and S, given the formulas Na_2S and MgS

b) Na and N, given the formulas NaF and Na_2O

45. Determine the number of protons, neutrons and electrons in

a) $^{16}O^{2-}$ **b)** $^{27}Al^{3+}$ **c)** ^{25}Mg **d)** ^{19}F **e)** $^{48}Ti^{4+}$

46. Determine the number of protons, neutrons and electrons in

a) $^{75}As^{5+}$ **b)** $^{31}P^{3-}$ **c)** ^{195}Pt **d)** ^{235}U **e)** $^{207}Pb^{2+}$

47. Write the symbol for the species with the number of protons and electrons shown below.

a) 34 protons and 36 electrons

b) 26 protons and 23 electrons

c) 47 protons and 47 electrons

48. Write the symbol for the species with the number of protons and electrons shown below.

a) 30 protons and 28 electrons

b) 81 protons and 78 electrons

c) 7 protons and 10 electrons

49. Distinguish between a group and a period. How are the properties of the elements in each related?

50. Identify each of the following elements:

a) the alkali metal in the same period as bromine

b) the lightest alkaline earth metal

c) the noble gas in the same period as silicon

d) the transition metal in the same family as iron and the same period as antimony

51. Identify each of the following elements:

a) the metalloid in the same family as gallium

b) the nonmetal in the same family as germanium

c) the only gas in the fifth period

d) the halogen in the same period as lead

e) the only metal in the same group as sulfur

52. Group the following elements in pairs that are likely to have similar chemical properties: Li, N, F, P, K, and Br.

53. Group the following elements in pairs that are likely to have similar chemical properties: Ca, S, Sr, He, O, Ar.