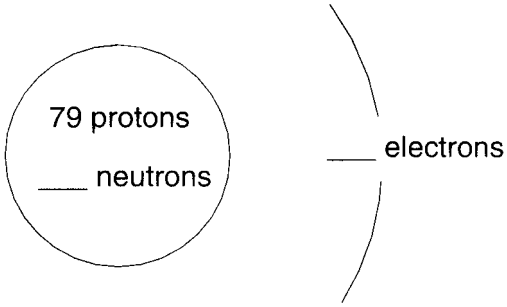
1. 40% of the isotopes of an element have a mass of 16 amu. 60% of the isotopes have a mass of 18 amu. Calculate the average atomic mass. Show all work.

2. In the early 1900s, evidence was discovered that atoms were not "hard spheres." It was shown that atoms themselves had an internal structure. One experiment involved gold metal foil.



a Complete the simple model for an atom of gold-197 by placing the correct numbers in the two blanks.

b In the gold-foil experiment, alpha particles were directed toward the foil. Most of the alpha particles passed directly through the foil with no effect. This result did not agree with the "hard spheres model" for the atom. What conclusion about the internal structure of the atom did this evidence show?

c In the same experiment, some of the alpha particles returned toward the source. What does this evidence indicate about the charge of the atom's nucleus?

Base your answers to questions **3** through **5** on on the information below.

In the modern model of the atom, each atom is composed of three major subatomic (or fundamental) particles.

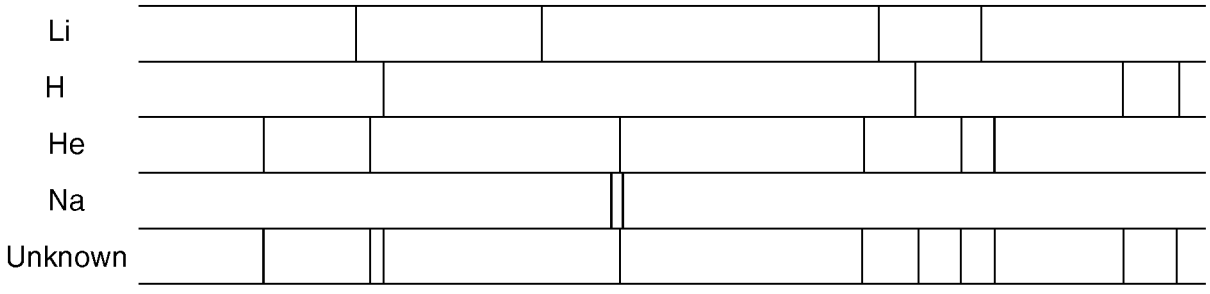
3. Name the subatomic particles contained in the nucleus of the atom.

4. State the charge associated with *each* type of subatomic particle contained in the nucleus of the atom.

5. What is the net charge of the nucleus?

Base your answers to questions **6** and **7** on the diagram below, which shows bright-line spectra of selected elements.

Bright-Line Spectra



6. Identify the *two* elements in the unknown spectrum.

7. Explain how a bright-line spectrum is produced, in terms of *excited state, energy transitions,* and *ground state.*

8. Fluorine is a Group 17 element. Fluorine is the most electronegative and reactive of all elements. It is a pale yellow, corrosive gas, which reacts with practically all organic and inorganic substances.

   a Draw the Lewis electron-dot structure for an *atom* of fluorine.

   b What is the definition (or your interpretation} of the term "electronegativity".

   c Explain why the electronegativity of elements in Group 17 decreases as you go down within that group.

9. Base your answers to the questions below on the following information:

   Potassium is a mineral which appears in abundance in all living plant and animal cells. The human body uses it to promote regular heartbeat, help build muscles, help contract muscles, regulate blood pressure, and control the water balance in body tissues and cells.
   Calcium is a mineral that primarily functions in your body by making your bones and teeth hard. The rest is in your blood and soft tissues; it helps your muscles contract and your blood clot, and helps your nervous system work properly.

   a According to your knowledge of atomic structure, explain why the calcium atom is smaller than potassium atom.

   b Potassium and calcium are rarely found as pure elements in nature. They are usually combined with other substances. Explain why this is so.

10. A knowledge of the *ionization energies* of elements can be very useful in predicting the activity and type of reaction an element will have.

    a What does the ionization energy quantitatively measure about an atom?

    b Why do ionization energies decrease from the top to the bottom of a group on the periodic table of elements?

    c Why do ionization energies increase from left to right across any period?

Base your answers to questions **11** and **12** on the information below.

11. Given: Samples of Na, Ar, As, Rb

    Explain your answer in terms of the Periodic Table of the Elements.

12. Which *two* of the given elements have the most similar chemical properties?

    _____

13. In a laboratory experiment, a student determined the mass of the product, $CaCl_2(s)$, to be 45.5 grams.

    a Calculate the gram formula mass of $CaCl_2(s)$. Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.]

    b Calculate the number of moles of $CaCl_2(s)$ produced. [Show all work. Indicate the correct answer in proper significant figures.]

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14. Given the unbalanced equation:
    $\_\_Fe_2O_3(s) + \_\_CO(g) \rightarrow \_\_Fe(l) + \_\_CO_2(g)$
    Balance the equation using smallest whole number coefficients.

15. Given the unbalanced equation:
    $\_\_Al_2(SO_4)_3 + \_\_ZnCl_2 \rightarrow \_\_AlCl_3 + \_\_ZnSO_4$
    balance the equation using smallest whole number coefficients.

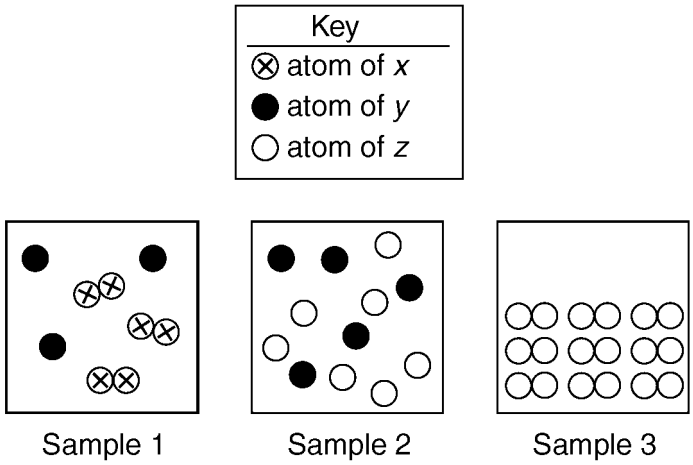
16. Given the compound $C_4H_{10}O_{8,}$

a Calculate the molar masss of the compound.

b Calculate the number of moles in 17.7 grams of the compound.

c What is the empirical formula for this compound?

Base your answers to questions **17** through **19** on the particle diagrams below, which show atoms and/or molecules in three different samples of matter at STP.



17. Which sample represents a pure substance?

18. When two atoms of *y* react with one atom of *z*, a compound forms. Using the number of atoms shown in sample 2, what is the maximum number of molecules of this compound that can be formed?

19. Explain why (x)(x) does *not* represent a compound.

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20. Hydrogen can be made by the reaction of magnesium with a strong acid such as hydrochloric acid, HCl, or sulfuric acid, H_2SO_4. The reaction with hydrochloric acid is shown below:

$$Mg(s) + 2\,HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$$

Since hydrogen gas is almost insoluble in water, it can be collected by displacement of water using an inverted bottle.

a Draw the Lewis electron-dot structure for a molecule of hydrogen gas.

b Based upon your knowledge of molecular structure, explain why hydrogen does not dissolve in water.

c Write a balanced chemical equation for the reaction of magnesium solid with sulfuric acid to form hydrogen gas and magnesium sulfate.

21. A student used a balance and a graduated cylinder to collect the following data:

Sample mass	10.23 g
Volume of water	20.0 mL
Volume of water and sample	21.5 mL

a Calculate the density of the element. Show your work. Include the appropriate number of significant figures and proper units.

b If the accepted value is 6.93 grams per milliliter, calculate the percent error.

c What error is introduced if the volume of the sample is determined first?

Answer Key

1. 17.2 amu

2. *a)* 118 neutrons, 79 electrons. *b)* Acceptable responses include, but are not limited to, these examples: – The atom's internal structure is mostly empty space *or* – mostly empty space
c) Acceptable responses include, but are not limited to, these examples: – The nucleus of the gold atoms have a positive charge. or – Both the nucleus of the gold atoms and the alpha particles have the same charge. or – positive charge

3. protons and neutrons

4. Protons are positively charged (+) and neutrons have no charge (0).

5. positive or (+)

6. H and He *or* hydrogen and helium.

7. Examples: –Excited state to ground state releases energy. –energy released — excited to ground –An electron absorbs energy and moves to a higher shell (energy level). As the electron returns to a lower shell (energy level), it releases energy in the form of a bright-line spectrum.

8. 

b) Electronegativity is the relative measure of how strongly the nucleus of an atom will attract electrons from another atom. c) As you go down the period the nuclear charge gets shielded by layers of more electrons and as the atom gets larger, the distance to the nuclear charge gets greater.

9. a) The calcium atom has a greater nuclear charge which pulls the electrons (that are in the same principal energy level) in closer to the nucleus.
b) They are very reactive metals.

10. a) The ionization energy is the amount of energy needed to remove the most loosely bound electron from an atom. b) The electrons are farther away in the lower periods so there is less pull from the nucleus. Also, there is shielding from the electrons that are closer to the nucleus. c) Electrons are held tighter to an atom because of the increase in nuclear charge.

11. Examples: – same number of valance electrons; both is same Group 1

12. Na and Rb

13. a) 40.1 + 2(35.5) = 101 grams b) 45.5g *x* 1.00 mole/101g = .450 mole

14. _1_Fe_2O_3(s) + _3_CO(g) → _2_Fe(*l*) + _3_CO_2(g)

15. _1_$Al_2(SO_4)_3$ + _3_$ZnCl_2$ → _2_$AlCl_3$ + _3_$ZnSO_4$

16. a) 186 grams b) .095 moles c) $C_2H_5O_4$

17. Allow credit for 3.

18. Allow credit for 2.

19. Acceptable responses: A compound must contain two or more different elements, only 1 kind of atom present.

20. 

b) Hydrogen is a non-polar molecule and cannot dissove in a polar substance like water. c) Mg(s) + H_2SO_4(aq) → H_2(g) + $MgSO_4$(aq)

21. *a* Examples:
– $\frac{10.23}{21.5 - 20.0}$c> = 6.8 or, – $\frac{10.23}{1.5}$c> = 6.8 – or $\frac{10.23\ g}{1.5\ ml}$c> = 6.8 g/ml

and accept only to the nearest tenth with a range from 6.7 – 6.9.

–Proper Units
g/ml
grams per milliliter

b Range of 1.8 – 2.0%.
c The density would increase because the sample was wet when weighed.