Name _____ Class _____ Date _____

Assessment

Atoms: The Building Blocks of Matter

The Atom: From Philosophical Idea to Scientific Theory

In the space provided, write the letter of the correct term or phrase that best completes each statement or best answers each question.

_____ **1.** John Dalton thought that atoms
- **a.** contain molecules.
- **b.** cannot be broken down further.
- **c.** are all composed of carbon.
- **d.** have no mass.

_____ **2.** Using improved chemistry equipment in the late 1700s, chemists observed that mass is neither created nor destroyed in a chemical reaction. This scientific law is called the law of
- **a.** definite proportions.
- **b.** gravity.
- **c.** conservation of mass.
- **d.** conservation of momentum.

_____ **3.** In an experiment, Alex and Rachel discover that their sample of table salt, also known as sodium chloride, NaCl, consists of 39.34% by mass sodium, Na, and 60.66% by mass chlorine, Cl. Later, Alex wonders what the percentage of Na might be in the table salt in his saltshaker at home. Rachel tells him, correctly, that it is
- **a.** 39.34%.
- **b.** 60.66%.
- **c.** 90%.
- **d.** impossible to tell, without analyzing the salt.

_____ **4.** The fact that every sample of a particular chemical compound contains the same elements in exactly the same proportions by mass is known as the law of
- **a.** conservation of energy.
- **b.** conservation of mass.
- **c.** atomic theory.
- **d.** definite proportions.

_____ **5.** A molecule of carbon monoxide, CO, has one atom of oxygen while a molecule of carbon dioxide, CO_2, has two. In a sample of CO containing 1 g of carbon, 1.33 g of oxygen will combine with the carbon to form the molecule. What is the mass of oxygen in a sample of CO_2 containing 1 g of carbon?

a. 1.33 g **b.** 3.0 g **c.** 2.66 g **d.** 0.0 g

_____ **6.** If two or more compounds are composed of the same two elements, then the ratio of the masses of the second element that is combined with a certain mass of the first element is always a ratio of small whole numbers. This statement is called the law of
a. definite proportions.
b. conservation of mass.
c. atomic theory.
d. multiple proportions.

_____ **7.** In 1808, John Dalton established his atomic theory. Which of the following is *not* part of Dalton's atomic theory?
a. All matter is composed of atoms.
b. An atom consists of a nucleus and a cloud of electrons.
c. Atoms cannot be subdivided, created, or destroyed.
d. In chemical reactions, atoms are combined, separated, or rearranged.

_____ **8.** Which of the following statements of Dalton's atomic theory describes conservation of mass?
a. All matter is composed of atoms.
b. Atoms of a given element are identical in size, mass, and other properties.
c. Atoms cannot be subdivided, created, or destroyed.
d. Atoms of different chemical elements combine in simple whole-number ratios to form chemical compounds.

_____ **9.** Which of the following statements of Dalton's atomic theory describes the law of multiple proportions?
a. All matter is composed of atoms.
b. Atoms of a given element are identical in size, mass, and other properties.
c. Atoms cannot be subdivided, created, or destroyed.
d. Atoms of different chemical elements combine in simple whole-number ratios to form chemical compounds.

_____ **10.** Which is one way that Dalton's atomic theory has been shown to be incorrect?
a. Atoms can change identity in chemical reactions.
b. Atoms can be split into subatomic particles.
c. Atoms can be destroyed by chemical reactions.
d. Some atoms of a particular element are identical to atoms of other elements.

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Atoms: The Building Blocks of Matter

The Structure of the Atom

In the space provided, write the letter of the correct term or phrase that best completes each statement or best answers each question.

_____ **1.** Experiments with cathode rays being deflected by a magnetic field show that cathode rays are composed of particles that are
- **a.** magnetic.
- **b.** negatively charged.
- **c.** positively charged.
- **d.** neutral in charge.

_____ **2.** Cathode rays are composed of particles that are now known as
- **a.** positrons.
- **b.** neutrons.
- **c.** protons.
- **d.** electrons.

_____ **3.** In 1911, Ernest Rutherford conducted his now famous goldfoil experiment. During the experiment, alpha particles bombarded a thin piece of gold foil. The alpha particles were expected to pass easily through the gold foil. Every now and then, however, an alpha particle bounced back—an unexpected result. Rutherford concluded that these particles were striking
- **a.** a tiny region of positive charge.
- **b.** a dense region of negative charge.
- **c.** a dense region of neutrons.
- **d.** a tiny region with a strong magnetic field.

_____ **4.** Rutherford called the region that deflected alpha particles
- **a.** an electron.
- **b.** a positron.
- **c.** a nucleus.
- **d.** a quark.

_____ **5.** The total volume of the nucleus of an atom is
- **a.** very large compared with the rest of the atom.
- **b.** very small compared with the rest of the atom.
- **c.** about the same size as an electron.
- **d.** smaller than a neutron.

_____ **6.** Except for in the simplest type of hydrogen atom, all nuclei consist of
- **a.** protons and electrons.
- **b.** neutrons and positrons.
- **c.** protons and neutrons.
- **d.** electrons and positrons.

_____ **7.** Electrons can be found
- **a.** inside protons.
- **b.** inside neutrons.
- **c.** attached to the nucleus.
- **d.** moving rapidly outside the nucleus.

_____ **8.** We know that objects with like electric charge repel one another. Which statement best explains why protons can remain close to one another in a nucleus?
- **a.** There is no electric charge in the nucleus of an atom.
- **b.** A short-range force, called the strong nuclear force, binds protons together.
- **c.** Protons are balanced electrically by electrons.
- **d.** Neutrons cancel out the electric force.

_____ **9.** Most of an atom is
- **a.** dense.
- **b.** fluid.
- **c.** empty.
- **d.** the nucleus.

_____ **10.** What is the charge of a neutron?
- **a.** positive
- **b.** negative
- **c.** neutral
- **d.** None of the above

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Assessment

Atoms: The Building Blocks of Matter

Counting Atoms

In the space provided, write the letter of the correct term or phrase that best completes each statement or best answers each question.

_____ **1.** The atomic number of an element is
- **a.** the mass of the element.
- **b.** 1 mol of the element.
- **c.** the number of protons in each atom of the element.
- **d.** the number of neutrons in each atom of the element.

_____ **2.** Hydrogen that is composed of atoms with two neutrons is called
- **a.** protium.
- **b.** deuterium.
- **c.** tritium.
- **d.** helium.

_____ **3.** Isotopes are atoms of the same element that have different
- **a.** masses.
- **b.** charges.
- **c.** numbers of electrons.
- **d.** atomic numbers.

_____ **4.** Mass number is
- **a.** the average atomic mass of an element.
- **b.** the total number of electrons in an atom of an element.
- **c.** the total number of protons in an atom of an element.
- **d.** the total number of protons and neutrons in an atom of an element.

_____ **5.** The isotope uranium-235 has 92 protons and 143 neutrons. Therefore, its mass number is
- **a.** 92.
- **b.** 235.
- **c.** 143.
- **d.** impossible to determine.

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_____ **6.** The nuclear symbol for uranium-235 should be written as
a. U-235. **b.** $^{235}_{92}U$. **c.** $^{235}_{143}U$. **d.** U.

_____ **7.** What is the definition of one atomic mass unit?
a. *1 g of any element*
b. *1 mol of any element*
c. $\frac{1}{12}$ *of the mass of a carbon-12 atom*
d. $\frac{1}{12}$ *of the mass of any atom*

_____ **8.** To take a weighted average of all the naturally occurring isotopes of an element in order to arrive at an average atomic mass, you would
a. multiply the mass of each isotope by the decimal fraction representing its abundance naturally, then add all these products together.
b. use the isotope with the largest mass.
c. use the isotope with the most average mass.
d. add all the masses of all of the isotopes, then divide by the number of isotopes.

_____ **9.** One mole is defined as
a. *the volume of a substance with a mass of 12 g.*
b. *the amount of a substance that contains as many particles as there are atoms in exactly 12 g of carbon-12.*
c. *the amount of a substance that contains as many particles as there are atoms in exactly 12 g of silver.*
d. *an amount of a substance that contains enough atoms to have a mass of 12 g.*

_____ **10.** The molar mass of an element is numerically equal to the element's
a. average number of electrons.
b. average number of protons.
c. average atomic mass.
d. average atomic number.

Atomic Structure

Name _____

Date _____

Group I. Draw a labeled diagram of each of the following atoms. Show the number of protons, the number of neutrons,

Z = atomic number

A = mass number

1. oxygen — Z 8, A 16
2. lithium — Z 3, A 7
3. calcium — Z 20, A 40
4. sulfur — Z 16, A 32
5. argon — Z 18, A 40
6. carbon — Z 6, A 12
7. potassium — Z 19, A 39
8. helium — Z 2, A 4
9. aluminum — Z 13, A 27
10. hydrogen — Z 1, A 1
11. beryllium — Z 4, A 9
12. fluorine — Z 9, A 19

(h) potassium ion (K^+)
(i) sulfur ion (S^{2-})
(j) magnesium ion (Mg^{2+})
(k) boron ion (B^{3+})
(l) argon ion (Ar^+)

(e) sodium ion (Na^+)
(f) bromide ion (Br^-)
(g) magnesium ion (Mg^{2+})
(h) sulfide ion (S^{2-})

(continued)

Molecular Mass and Mole Calculations

Name _____

Date _____

Group I. Find the molecular mass or formula mass for each of the compounds shown below.

1. H_3PO_4
2. $AlCl_3$
3. $Dy(OH)_3$
4. $K_2C_4H_4O_6$
5. H_2SO_4
6. N_2O_5
7. $CuSO_4 \cdot 5H_2O$
8. $NiSO_4$
9. $Sn(OH)_4$
10. $(NH_4)_3PO_4$
11. $Fe(C_2H_3O_2)_3$
12. SO_2
13. $KAl(SO_4)_2 \cdot 12H_2O$
14. $NaIO_4$
15. $Pr(OH)_3$
16. $K_4Fe(CN)_6$
17. Nd_2O_3
18. $Sb(NO_3)_3$
19. K_3PO_4
20. $Ga_2(SO_4)_3$

(continued)

Calculate the number of moles in each of the following quantities.

19. atoms of each element in 3.35 moles of aspirin ($C_9H_8O_4$)
20. positive and negative ions in 1.75 moles of calcium fluoride (CaF_2)

Determine the molar mass of each of the following compounds.

21. formic acid (CH_2O_2)
22. ammonium dichromate ($(NH_4)_2Cr_2O_7$)
23. lead(II) nitrate ($Pb(NO_3)_2$)
24. magnesium bromide ($MgBr_2$)
25. 245 g aluminum nitrite ($Al(NO_2)_3$)

Determine the percent composition of each of the following compounds.

26. manganese oxide (MnO)
27. propanol (C_3H_8O)
28. calcium phosphate ($Ca_3(PO_4)_2$)

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PRACTICE PROBLEMS

Problem

Identify and calculate the number of representative particles in each of the following quantities.

1. 2.15 moles of gold
2. 0.151 mole of nitrogen oxide
3. 11.5 moles of potassium bromide

Calculate the number of moles of the substance that contains the following number of representative particles.

4. 8.92×10^{23} atoms of barium
5. 5.50×10^{25} molecules of carbon monoxide
6. 2.66×10^{22} formula units of potassium iodide

Determine the mass in grams of each of the following quantities.

7. 1.24 moles of beryllium
8. 3.35 moles of calcium
9. 0.155 mole of sulfur

Calculate the number of moles in each of the following samples.

10. 6.35 g lithium
11. 346 g zinc
12. 115 g nickel

How many atoms are in the following samples?

13. 1.24 g cobalt
14. 0.575 g cesium
15. 65.6 g silicon

Which quantity has the greatest mass?

16. 4.16×10^{23} atoms of radium
17. 1.50×10^{20} atoms of cadmium
18. 1.33×10^{24} atoms of argon