1. Given the particle diagram:

Key
O = atom of an element
● = atom of a different element
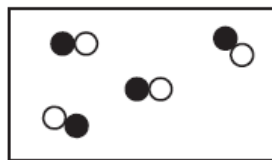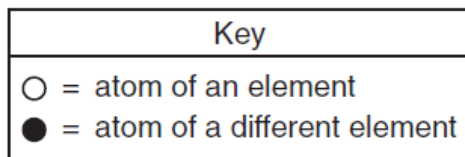
   Which type of matter is represented by the particle diagram?

   A) a heterogeneous mixture   C) a compound
   B) an element   D) a homogeneous mixture

2. What is the chemical formula for lead(IV) oxide?

   A) Pb_2O B) Pb_4O C) PbO_4 D) PbO_2

3. In the formula $X_2(SO_4)_3$, the X represents a metal. This metal could be located on the Periodic Table in

   A) Group1   B) Group 2   C) Group 13   D) Group 14

4. Which is a binary compound?

   A) $NaNO_3$ B) $MgSO_4$ C) $CaCl_2$ D) KOH

5. During all chemical reactions, mass, energy, and charge are

   A) absorbed   B) released   C) formed   D) conserved

6. Which equation shows conservation of atoms?

   A) $H_2 + O_2 \rightarrow 2H_2O$ C) $2H_2 + O_2 \rightarrow 2H_2O$
   B) $2H_2 + 2O_2 \rightarrow 2H_2O$ D) $H_2 + O_2 \rightarrow H_2O$

7. Given the unbalanced equation:

   $$\underline{\quad} Al + \underline{\quad} CuSO_4 \rightarrow \underline{\quad} Al_2(SO_4)_3 + \underline{\quad} Cu$$
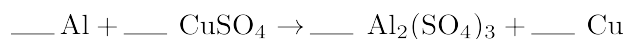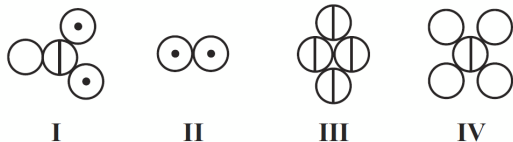
   When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?

   A) 1   B) 2   C) 3   D) 4
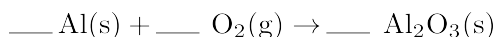
8. Given four particle models:

Which two models can be classified as elements?

A) II and IV   B) I and II   C) I and IV   D) II and III

9. If an equation is balanced properly, both sides of the equation must have the same number of

A) moles of molecules   C) atoms
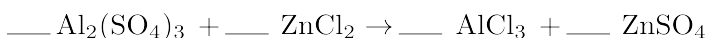B) coefficients   D) molecules

10. Given the unbalanced equation:

$$\_\_\_ Al(s) + \_\_\_ O_2(g) \rightarrow \_\_\_ Al_2O_3(s)$$

When this equation is correctly balanced using smallest whole numbers, what is the coefficient of $O_2(g)$?

A) 6   B) 2   C) 3   D) 4

11. When the equation

$$\_\_\_ Al_2(SO_4)_3 + \_\_\_ ZnCl_2 \rightarrow \_\_\_ AlCl_3 + \_\_\_ ZnSO_4$$

is correctly balanced using the smallest whole number coefficients, the sum of the coefficients is

A) 9   B) 8   C) 5   D) 4

12. What is the IUPAC name for the compound $ZnSO_4$?

A) zinc sulfide   C) zinc sulfur oxide
B) zinc sulfite   D) zinc sulfate

13. Which list includes three types of chemical reactions?

A) solidification, double replacement, and single replacement
B) decomposition, single replacement, and double replacement
C) decomposition, single replacement, and solidification
D) solidification, double replacement, and decomposition

14. Which reaction releases the greatest amount of energy per kilogram of reactants?

A) $2C + H_2 \rightarrow C_2H_2$
B) $^1_0n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^1_0n$
C) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$
D) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$

15. What is the correct formula for ammonium carbonate?

A) $(NH_4)_2(CO_3)_2$ B) $NH_4(CO_3)_2$ C) $(NH_4)_2CO_3$ D) NH_4CO_3

16. In which type of chemical reaction do two or more reactants combine to form one product, only?

A) synthesis   C) decomposition
B) single replacement   D) double replacement

17. Given the balanced equations representing two chemical reactions:

$$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$

$$2NaCl \rightarrow 2Na + Cl_2$$

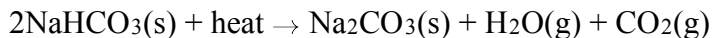Which type of chemical reactions are represented by these equations?

A) synthesis and double replacement
B) single replacement and double replacement
C) synthesis and decomposition
D) single replacement and decomposition

18. Which balanced equation represents a chemical change?

A) $H_2O(\ell) \rightarrow H_2O(s) + energy$ C) $H_2O(\ell) + energy \rightarrow H_2O(g)$
B) $2H_2O(\ell) + energy \rightarrow 2H_2(g) + O_2(g)$ D) $H_2O(g) \rightarrow H_2O(\ell) + energy$

19. $F_2(g) + CaBr_2(g) \rightarrow CaF_2(g) + Br_2(g)$

What type of reaction is shown above?

A) decomposition   C) synthesis
B) single replacement   D) double replacement

20. An atom of an element has a total of 12 electrons. An ion of the same element has a total of 10 electrons. Which statement describes the charge and radius of the ion?

A) The ion is positively charged and its radius is smaller than the radius of the atom.
B) The ion is positively charged and its radius is larger than the radius of the atom.
C) The ion is negatively charged and its radius is larger than the radius of the atom.
D) The ion is negatively charged and its radius is smaller than the radius of the atom.

21. Which Lewis electron-dot diagram is correct for a S^{2-} ion?

A) $\left[:\overset{\cdot\cdot}{\underset{\cdot}{S}}\cdot\right]^{2-}$ B) $\left[\cdot\overset{\cdot\cdot}{S}\cdot\right]^{2-}$ C) $\left[\overset{\cdot\cdot}{S}\right]^{2-}$ D) $\left[:\overset{\cdot\cdot}{\underset{\cdot\cdot}{S}}:\right]^{2-}$

22. Which element would most likely be found uncombined in nature?

A) Ag   B) Mg   C) K   D) I

Base your answers to questions **23** through **25** on the information below.

The Solvay process is a multistep industrial process used to produce washing soda, $Na_2CO_3(s)$. In the last step of the Solvay process, $NaHCO_3(s)$ is heated to 300°C, producing washing soda, water, and carbon dioxide. This reaction is represented by the balanced equation below.

$2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$

23. Determine the total mass of washing soda produced if 3360. kilograms of $NaHCO_3$ reacts completely to produce 360. kilograms of H_2O and 880. kilograms of CO_2.

24. Identify the type of chemical reaction represented by the equation.

25. Write the IUPAC name for washing soda.

_____

Base your answers to questions **26** and **27** on the information below and on your knowledge of chemistry.

At STP, Cl_2 is a gas and I_2 is a solid. When hydrogen reacts with chlorine, the compound hydrogen chloride is formed. When hydrogen reacts with iodine, the compound hydrogen iodide is formed.

26. Balance the equation below for the reaction between hydrogen and chlorine, using the smallest whole-number coefficients.

_____ $H_2(g)$ + _____ $Cl_2(g) \rightarrow$ _____ $HCl(g)$

27. Explain, in terms of intermolecular forces, why iodine is a solid at STP but chlorine is a gas at STP.

Base your answers to questions **28** through **30** on the information below.

Arsenic is often obtained by heating the ore arsenopyrite, FeAsS. The decomposition of FeAsS is represented by the balanced equation below.

$$\text{FeAsS}(s) \xrightarrow{\text{heat}} \text{FeS}(s) + \text{As}(g)$$
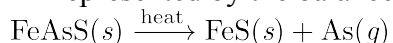
In the solid phase, arsenic occurs in two forms. One form, yellow arsenic, has a density of 1.97 g/cm^3 at STP. The other form, gray arsenic, has a density of 5.78 g/cm^3 at STP. When arsenic is heated rapidly in air, arsenic(III) oxide is formed.

Although arsenic is toxic, it is needed by the human body in very small amounts. The body of a healthy human adult contains approximately 5 milligrams of arsenic.

28. Write the formula for the compound produced when arsenic is heated rapidly in air.

29. Explain, in terms of the arrangement of atoms, why the two forms of arsenic have different densities of STP.

30. What is the oxidation state of the iron in the iron compound formed as a product in the above chemical equation?