MULTIPLE CHOICE.
Write the letter of the term or phrase that best completes each statement or best answers each question on the answer sheet provided.

_____1. A compound differs from a mixture because it
   a. always remains frozen even at high temperatures.
   b. is formed from two cations.
   c. is held together by chemical bonds.
   d. can form only in the presence of heat energy.

_____2. Often atoms join so that each atom will have
   a. an even number of electrons.
   b. an outermost energy level that is full of electrons.
   c. an equal number of protons and neutrons
   d. more electrons than either protons or neutrons.

_____3. The bonds that hold atoms together behave most like
   a. snap-together blocks
   b. glue
   c. rubber cement
   d. flexible springs

_____4. When two hydrogen atoms bond, the positive nucleus of one atom attracts the
   a. negative nucleus of the other atom.
   b. positive electron of the other atom.
   c. negative electron of the other atom.
   d. positive nucleus of the other atom.

_____5. An ionic bond is a bond that forms between
   a. ions with opposite charges.
   b. atoms with neutral charges.
   c. one atom’s nucleus and another atom’s electrons.
   d. the electrons of two different atoms.

_____6. In which type of bond do atoms share electrons?
   a. covalent bonds
   b. metallic bonds
   c. ionic bonds
   d. polyatomic bonds

_____7. A carbon atom can bond to four other atoms because it has
   a. four different cations
   b. four valence electrons
   c. two inner energy levels
   d. no protons in its nucleus
8. Which of the following is a compound?
   a. salt
   b. paint
   c. soup
   d. air

9. Atoms and ions are held together by
   a. nuclear bonds
   b. stick bonds
   c. physical bonds
   d. chemical bonds

10. Which of the following models could be used to compare the sizes of atoms in a molecule?
    a. ball-and-stick
    b. structural
    c. space-filling
    d. formula

11. There are strong bonds between the atoms in a piece of quartz. These bonds give quartz a
    a. low melting point
    b. high melting point
    c. low molecular mass
    d. high molecular mass

12. Sugar has a lower melting point than salt because sugar is made of
    a. atoms
    b. ions
    c. molecules
    d. crystals

13. Atoms sometimes form bonds to
    a. lose energy
    b. become more stable
    c. give away neutrons
    d. give away protons

14. Copper atoms are held together by __________ bonds.
    a. metallic
    b. hydrogen
    c. ionic
    d. covalent

15. Sodium has one electron in its outer shell and chlorine has seven electrons in its outer shell. The atoms will form a(n) __________ bond by __________ their electrons.
    a. covalent, transferring
    b. covalent, sharing
    c. ionic, transferring
    d. ionic, sharing
16. The chemical formula for an ionic compound of aluminum and chlorine is
   a. AlCl
   b. ClAl
   c. AlCl₃
   d. Al₃Cl

17. The chemical formula for an ionic compound of potassium and oxygen is
   a. KO
   b. K₂O
   c. K₂O₂
   d. KO₂

18. Each molecule of table sugar, C₁₂H₂₂O₁₁, contains
   a. 0 atoms of carbon
   b. 1 atom of carbon
   c. 6 atoms of carbon
   d. 12 atoms of carbon

19. Covalent bonds are formed between
   a. ions
   b. metal atoms
   c. nonmetal atoms
   d. compounds

20. Copper is a good conductor of electricity because its electrons
   a. are positively charged
   b. can move from atom to atom
   c. have a -2 charge
   d. are repelled by protons

21. Two substances are physically blended together without chemically reacting. They retain (keep) their original chemical and physical properties. What is this combination of substances called?
   a. element
   b. mixture
   c. compound
   d. atom

22. The metal, silver, allows conduction of an electric current because its electrons are
   a. not negatively charged
   b. covalently shared
   c. able to move between atoms
   d. drawn toward each other

23. Energy stored in the electrical bonds that hold atoms and molecules of all substances is called
   a. mechanical energy
   b. chemical energy
   c. kinetic energy
   d. electrical energy
24. A student is testing the conductivity of two substances. Substance A has high conductivity and Substance B has low conductivity. Based on this information, what must be true about these two substances?
   a. The atomic nuclei in Substance A have more mass than the atomic nuclei in Substance B
   b. Substance A contains a higher percentage of radioactive atoms than does Substance B
   c. There is more energy stored in chemical bonds in Substance A than there is in Substance B.
   d. Electrons in Substance A are able to move more easily than electrons in Substance B.

25. Because the overall charge in a compound must be ____________, the charge of iron in Fe$_2$O$_3$ can be calculated as 3$^+$. 
   a. 2$^+$
   b. 0
   c. 1$^+
   d. 1$^-

26. In the compound TiO$_2$, titanium has a charge of 
   a. 3$^+$
   b. 4$^-$
   c. 4$^+$
   d. 2$^+$

27. A compound is held together by 
   a. chemical bonds. 
   b. gravity. 
   c. physical bonds. 
   d. magnetism.

28. Each molecule of hydrochloric acid, HCl, contains one atom of hydrogen and 
   a. one atom of chlorine. 
   b. one atom of oxygen. 
   c. two atoms of chlorine. 
   d. two atoms of oxygen.

29. In which substance do the molecules have the strongest attractions to one another? 
   a. sugar, a solid 
   b. hydrogen, a gas 
   c. sulfuric acid, a liquid 
   d. water, a liquid

30. Solid ionic compounds have very high melting points because they 
   a. are positively charged. 
   b. contain metallic elements. 
   c. are made of elements that are solid at room temperature. 
   d. contain charged ions that are locked tightly together.

31. The forces that hold different atoms or ions together are 
   a. electric currents. 
   b. chemical bonds. 
   c. physical bonds. 
   d. nuclear forces.

32. Which of the following models would show the bond angle? 
   a. ball-and-stick 
   b. structural 
   c. space-filling 
   d. formula
33. Oxygen atoms have six electrons in their outer shells. When two oxygen atoms bond, they will form a(n) ________________ bond by______________ their electrons.
   a. covalent, transferring  
   b. covalent, sharing  
   c. ionic, transferring  
   d. ionic, sharing

34. In the compound, H₂SO₄, there are _______ different elements.
   a. three  
   b. four  
   c. two  
   d. ten

35. The total number of atoms in NaC₂H₃O₂ is _______.
   a. seven  
   b. eight  
   c. four  
   d. twelve

36. The total number of atoms in (NH₄)₃PO₄ is _______.
   a. eleven  
   b. forty-eight  
   c. four  
   d. twenty

TRUE OR FALSE.

1. An atom is chemically stable when its outermost energy level has all the electrons it can hold.

2. Table salt, NaCl, is an ionic compound.

3. If an atom is chemically stable, it easily forms compounds with other atoms.

4. In an ionic compound, electrons are shared.

5. Metals and nonmetals usually combine by forming ionic compounds.

6. A covalent bond can have more than two shared electrons.

7.Ionic compounds have a neutral overall charge.

8. Atoms in covalent bonds always share their electrons equally.

9. If an atom has a low number of valence electrons, it has low ionization energy.

10. If an atom has a high number of valence electrons, it has a high electron affinity.

11. Triple bonds are the weaker than double bonds.

12. The properties of a compound are the same as the properties of the elements that make up the compound.

CRISS-CROSS.
Write the formulas of the compounds produced from the listed ions.

<table>
<thead>
<tr>
<th>Cl⁻</th>
<th>S²⁻</th>
<th>OH⁻</th>
<th>SO₄²⁻</th>
<th>PO₄³⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>K⁺</td>
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</tbody>
</table>
CLASSIFY/IDENTIFY #1.
Identify each of the following as being a characteristic of an ionic bond (IB) or covalent bond (CB) or metallic bond (MB).

_____ 1. Forms between a positive and negative ion
_____ 2. Usually occurs between nonmetals
_____ 3. Formed by atoms in metals packing electrons closely together
_____ 4. Network of bonded ions
_____ 5. Forms a molecule
_____ 6. Allows copper to bend and conduct electricity
_____ 7. Electrons shared
_____ 8. Usually forms between a metal and a nonmetal
_____ 9. Creates compounds with very high boiling points
_____ 10. Electrons are gained or lost (transferred)
_____ 11. Creates compounds with low boiling points
_____ 12. Can be polar or nonpolar
_____ 13. Positive and negative ions are formed

CLASSIFY/IDENTIFY #2.
Classify the following compounds as ionic (metal + nonmetal), covalent (nonmetal + nonmetal) or both (compound containing a polyatomic ion)

_____ 1. CaCl₂
_____ 2. CO₂
_____ 3. Na₂CO₃

CLASSIFY/IDENTIFY #3.
Classify the following compounds as polar covalent (PC) or non-polar covalent (NPC).

_____ 1. Cl₂
_____ 2. NH₃
MATCHING.
A. Ionic bond  B. Electron affinity  C. Ions
D. Ionization energy  E. Covalent bond  F. Metallic bonds
G. Crystal lattice  H. Polar covalent bond  I. Non-polar covalent bond
J. Anion  K. Cation

1. Bond in which one atom gives up or transfers one or more electrons to another atom accepts electrons.
2. The amount of energy required to remove electrons from an atom.
3. Tendency of an atom to gain electrons when forming bonds.
4. Three-dimensional pattern of ions that repeats itself.
5. A bond in which atoms share electrons.
6. Bond in which many electrons are shared by many atoms.
7. Atoms with a positive or negative charge.
8. Ion with a positive charge.
9. When two atoms of the same element form a covalent bond, they share electrons equally.
10. In this type of covalent bond, atoms of different elements do not share electrons equally.
11. Ion with a negative charge.

LEWIS DOT
1. Write the formula for the compound illustrated to the right.

2. What type of bond is shown? (single, double, triple)
1. All of these atoms lend electrons and form positive ions EXCEPT _________________.

2. The diagram above shows the oxidation numbers of certain groups in the periodic table. According to the diagram, which group is LEAST likely to combine with other elements to form compounds?
   
   a. Group 1
   b. Group 14
   c. Group 17
   d. Group 18
3. The ionic compounds above contain charged, covalently bonded groups of atoms that act like a single atom. This group is called ____________________.
   a. hydrates
   b. binary compounds
   c. polar molecules
   d. polyatomic ions

4. The elements whose atoms are pictured to the right all belong to period 2 of the periodic table. It would require the greatest amount of energy to remove an electron from which element?
   a. Li
   b. N
   c. F
   d. Ne

5. According to the information above, a polyatomic ion is a(n) ____________________.
   a. atom with a net charge
   b. charged, covalently bonded group of atoms
   c. group of covalently bonded atoms with a net charge of zero
   d. ionically bonded group of atoms

6. What process is taking place in the chemical combinations above?
   a. electron transfer
   b. electron sharing
   c. electron gain
   d. electron loss
7. Which of the following is the reason why atoms of sodium and chlorine attract each other in a salt crystal?
   a. Sodium has a positive charge and chlorine has a negative charge.
   b. Sodium has a negative charge and chlorine has a positive charge.
   c. Both have a positive charge.
   d. Both have a negative charge.

8. The picture above shows models of polar molecules. Which of these is the major characteristic of polar molecules?
   a. They contain at least two hydrogen atoms.
   b. They contain a metal and a nonmetal.
   c. They have a triangular shape created by the large size of negative oxygen molecules.
   d. They have a slightly positive end and a slightly negative end.

9. The elements whose atoms are pictured above all belong to Period 2 of the periodic table. It would require the greatest energy to remove an electron from which element?
   a. Li
   b. N
   c. F
   d. Ne
10. Calcium is a metal with an oxidation number of 2⁺. Chlorine is a nonmetal with an oxidation number of 1⁻. Which of the following would be the chemical formula for the compound formed by these two elements?
   a. CaCl
   b. CaCl₂
   c. Ca₂Cl
   d. CaCl₃

11. Ionic compounds are usually formed by ionic bonding between metals and nonmetals. Which of the following is not an ionic compound?
   a. H₂SO₄
   b. NH₄Cl
   c. Mg(OH)₂
   d. NaCl
Chapter 6 Test
The Structure of Matter

ANSWER SHEET
MULTIPLE CHOICE.

TRUE OR FALSE.

CLASSIFY/IDENTIFY #2

CLASSIFY/IDENTIFY #3

MATCHING

CLASSIFY/IDENTIFY # 1

LEWIS DOT

OGT

CRISS CROSS

<table>
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<tr>
<th>Cl^-</th>
<th>S^{2-}</th>
<th>OH^-</th>
<th>SO_4^{2-}</th>
<th>PO_4^{3-}</th>
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Chapter 6 Test
The Structure of Matter
EXTENDED RESPONSE. PART 1
CHOOSE ONE OF THE FOLLOWING. (6 points) Circle the question you are answering.
1. How does the type of chemical bonds present in a substance affect the substance’s properties? Give at least two examples.

2. Compare and contrast ionic and covalent bonds. Give an example of a compound that is formed using each type of bond.

EXTENDED RESPONSE. PART 2.
CHOOSE ONE OF THE FOLLOWING. (6 points). Circle the question you are answering.
3. Identify the types of bonds in NaCl and O₂. Describe the activity of the valence electrons in both. You may want to include a Lewis Dot diagram.

4. Explain the relationship between an element’s oxidation number and its group on the periodic table to which it belongs.