Comparison of Properties of Ionic and Covalent Compounds

Because of the nature of ionic and covalent bonds, the materials produced by those bonds tend to have quite different macroscopic properties. The atoms of covalent materials are bound tightly to each other in stable molecules, but those molecules are generally not very strongly attracted to other molecules in the material. The atoms (ions) in ionic materials show strong attractions to other ions in their vicinity. This generally leads to low melting points for covalent solids, and high melting points for ionic solids. For example, the molecule carbon tetrachloride is a non-polar covalent molecule, CCl₄. It's melting point is -23°C. By contrast, the ionic solid NaCl has a melting point of 800°C.

Properties of Covalent Compounds
- Gases, liquids, or solids (made of molecules)
- Atoms share electrons to become stable.
- Usually occurs between non-metals.
- Hydrogen and another non-metal chemically combines through covalent bonding.
- Low melting and boiling points
- Poor electrical conductors in all phases
- Many soluble in non-polar liquids but not in water

Properties of Ionic Compounds
- Crystalline solids (made of ions)
- Metal atoms give electrons while non metal atoms get electrons to become stable.
- Usually occurs between metals and non-metals.
- High melting and boiling points
- Conduct electricity when melted
- Many soluble in water but not in non-polar liquid
Clarifying Questions:

1. **Why do solid covalent compounds (molecules) have low melting points?**

2. **Why do solid ionic compounds (ions) have high melting points?**

3. **How are carbon tetrachloride and sodium chloride different from each other?**

**Instructions:** Classify the following properties as either Ionic or Covalent compounds. Write ionic or covalent on the space before each property.

- 4. Atoms share electrons to become stable.
- 5. High melting and boiling points
- 6. Conduct electricity when melted
- 7. Usually occurs between non-metals.
- 8. Poor electrical conductors in all phases
- 9. Many soluble in non-polar liquids but not in water
- 10. Crystalline solids (made of ions)
- 11. Metal atoms give electrons while non metal atoms get electrons to become stable
- 12. Usually occurs between metals and non-metals.
- 14. Low melting and boiling points
- 15. Many soluble in water but not in non-polar liquid

**Classify the following as metal or non-metal and ionic or covalent compounds.**

<table>
<thead>
<tr>
<th>Compound</th>
<th>First element/atom (metal or non-metal)</th>
<th>Second element/atom (metal or non-metal)</th>
<th>Ionic or Covalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>Carbon or C is a non metal</td>
<td>Hydrogen or H in this case is exhibiting non-metallic properties.</td>
<td>covalent</td>
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<tr>
<td>MgCl₂</td>
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<tr>
<td>H₂O</td>
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<td></td>
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<tr>
<td>CCl₄</td>
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<tr>
<td>HF</td>
<td></td>
<td>Hydrogen or H is this case is exhibiting metallic properties.</td>
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<tr>
<td>HCl</td>
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<tr>
<td>NaCl</td>
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<td></td>
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<tr>
<td>Mg₃P</td>
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</tbody>
</table>
Covalent Compounds Worksheet

1) Based on the properties of the following materials, determine whether they are made of primarily ionic compounds or covalent compounds:
   a) telephone receiver: 
   b) concrete: 
   c) gasoline: 
   d) candy corn: 

2) Name the following covalent compounds:
   a) SiF$_4$ 
   b) N$_2$S$_3$ 
   c) HBr 
   d) Br$_2$ 

3) Write the formulas for the following covalent compounds:
   a) diboron hexahydride 
   b) nitrogen tribromide 
   c) sulfur hexachloride 
   d) diphosphorus pentoxide 

4) Write the empirical formulas for the following compounds:
   a) C$_2$H$_4$O$_2$ 
   b) boron trichloride 
   c) methane 
   d) C$_6$H$_{12}$O$_6$ 

5) List three differences between ionic and covalent compounds:
6) Explain why ionic compounds are formed when a metal bonds with a nonmetal but covalent compounds are formed when two nonmetals bond.

7) What are the shapes of the following molecules?
   a) carbon disulfide ________________________________
   b) boron trifluoride _______________________________
   c) carbon tetrafluoride _____________________________

8) What does electronegativity have to do with bond polarity?

9) Explain how hydrogen bonding takes place.

10) Why is the bond length of nitrogen much shorter than the bond length of chlorine?

11) What is an organic compound?