Worksheet 3.1
Ionic solids

NAME: **CLASS:**

INTRODUCTION

This worksheet looks at the formation and bonding of ionic compounds and their properties.

<table>
<tr><th>No.</th><th>Question</th><th>Answer</th></tr>
<tr><td>1</td><td>Reactions between which of the following pairs of elements would be expected to form ionic compounds?
a Carbon and oxygen
b Tin and chlorine
c Sodium and fluorine
d Zinc and copper</td><td></td></tr>
<tr><td>2</td><td colspan="2">After considering the electron configuration of the following metals, determine the number of electrons each atom will lose, and the formula of the ion they will form when they react with a non-metal.
<table>
<tr><th>Metal</th><th>Number of electrons lost</th><th>Formula of ion formed</th></tr>
<tr><td>Calcium</td><td></td><td></td></tr>
<tr><td>Potassium</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>3</td><td colspan="2">After considering the electron configuration of the following non-metals, determine the number of electrons each atom will gain, and the formula of the ion they will form when they react with a metal.
<table>
<tr><th>Non-metal</th><th>Number of electrons gained</th><th>Formula of ion formed</th></tr>
<tr><td>Chlorine</td><td></td><td></td></tr>
<tr><td>Nitrogen</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>4</td><td>Give the formula of the ionic compound formed between the following pairs of ions:
a Cu^{2+} and F^{-}
b Al^{3+} and O^{2-}</td><td></td></tr>
<tr><td>5</td><td>Element A, from group 13, reacts with element B, from group 17, to form a compound. What is the formula of this compound?</td><td></td></tr>
<tr><td>6</td><td>An ionic compound has the formula A_3B_2. Elements A and B could be found in which groups of the periodic table?</td><td></td></tr>
</table>

7	Draw electron dot diagrams to represent the transfer of electrons and the number of atoms required to produce each of the following ionic compounds. **a** Sodium oxide from the reaction of sodium with oxygen atoms. **b** Magnesium sulfide from the reaction of magnesium with sulfur.	
8	Assuming that the ions are arranged in the same way, which of the following ionic compounds would have the higher melting point: KF or CaO? Explain your reasoning.	
9	Sodium chloride is an excellent conductor of electricity when dissolved in water, but in the solid state does not conduct at all. Explain this observation in terms of the ionic bonding model.	
10	Sodium is a soft malleable substance, yet sodium chloride is a hard brittle substance. Explain why NaCl is brittle but Na is malleable.	

Worksheet 3.1: Solutions
Ionic solids

No.	Answer
1	**b** Tin and chlorine **c** Sodium and fluorine 2
2	Calcium – lose 2 electrons to form Ca^{2+} Potassium – lose 1 electron to form K^+
3	Chlorine – gain 1 electron to form Cl^- Nitrogen – gain 3 electrons to form N^{3-}
4	**a** CuF_2 **b** Al_2O_3
5	A^{3+} bonds with B^- to form AB_3
6	As the charges must be balanced, three A^{2+} ions are required to balance two B^{3-} ions. A is in Group 2, B is in Group 15.
7	**a** Two Na atoms (2,8,1) each lose one electron to one O atom (2, 6). The ions formed are Na^+ (2, 8) and O^{2-} (2, 8). (see page 67 in the text book for similar electron dot diagrams) **b** Each Mg atom (2, 8, 2) will lose two electrons to a sulfur atom (2, 8, 6). The ions formed are Mg^{2+}(2, 8) and S^{2-} (2, 8, 8).
8	CaO has the higher melting point as the ionic bond is stronger. This is possibly because the ions in CaO (Ca^{2+} and O^{2-}) have larger charges than the ions in KF (K^+ and F^-). Ions with larger charges will attract one another more strongly than ions with smaller charges.
9	In order for a substance to conduct electricity, it must have charged particles (ions or electrons) that are free to move. The ions that make up solid sodium chloride are trapped in the solid lattice and are not free to move; so it cannot conduct. When dissolved in water (or melted), these ions break away from the rigid lattice and are mobile. As a result, electricity can be conducted.
10	When sufficient force is applied to the NaCl ionic lattice, it is possible to disrupt the alignment of the positive and negative ions in such a way that the same charges line up with each other. The repulsive electrostatic forces cause the crystal to shatter. However, when the lattice of positive ions in sodium is disrupted, the delocalised electrons are still present between the positive ions, maintaining the metallic bonding (attraction between the delocalised electrons and the positive ions) that hold the lattice together. The sodium therefore does not shatter, but it is malleable.