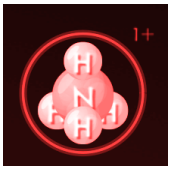
IONIC BONDING - GENERAL CHEMISTRY
FORMATIVE ASSESSMENT - KEY

STUDENT CHECK FOR UNDERSTANDING

Concepts:
Net Compound Neutrality, One Type of Cation to One Type of Anion, Cation-to-Anion Ratios, Polyatomic Ions

DIRECTIONS:
In each available box in the grid below, write out the chemical formula and cation-to-anion ratio of the compound that would result from combining each cation and anion. Check your answers using the Ionic Bonding Sandbox.

		Anion				
						
Cation		$LiCl$ 1:1	Li_2O 2:1	Li_3N 3:1	$Li_3(PO_4)$ 3:1	Li_2SO_4 2:1
		$MgCl_2$ 1:2	MgO 1:1	Mg_3N_2 3:2	$Mg_3(PO_4)_2$ 3:2	$MgSO_4$ 1:1
		$FeCl_3$ 1:3	Fe_2O_3 2:3	FeN 1:1	$Fe(PO_4)$ 1:1	$Fe_2(SO_4)_3$ 2:3
		NH_4Cl 1:1	$(NH_4)_2O$ 2:1	$(NH_4)_3N$ 3:1	$(NH_4)_3PO_4$ 3:1	$(NH_4)_2SO_4$ 2:1

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One interesting phenomenon in chemistry is that when substances are dissolved in a solvent like water, they lower the temperature at which that solvent freezes. This concept is known as freezing point depression. One common application of freezing point depression is in using road salt to keep ice and snow from collecting on roads and sidewalks during winter. Certain substances are more effective than others at lowering the freezing point of a solvent like water. In fact, the more individual particles that the substance produces in the solution, the lower it depresses the freezing point. It is for that reason that many ionic compounds tend to be particularly effective. A substance like glucose ($C_6H_{12}O_6$) will remain whole when dissolved in water, but a substance like potassium iodide (KI) will split into its ionic components - K^+ and I^-. At the same concentrations, a glucose molecule in water produces only one particle and does not lower the freezing point of water as much as potassium iodide which produces two particles.

Using the information provided in the paragraph above, explain why calcium chloride ($CaCl_2$) would be more effective at preventing a road from becoming icy than sodium chloride (NaCl).

Calcium chloride is more effective at de-icing roads because of its 1:2 cation-to-anion ratio. When calcium chloride dissolves, it forms three separate particles — one calcium ion and two chloride ions. However, sodium chloride, due to its 1:1 cation-to-anion ratio, only forms two separate particles when dissolved — one sodium ion and one chloride ion.

Which of the chlorides from the grid on page 1, would be **most effective** at lowering the freezing point of water, even more so than calcium chloride or sodium chloride? Explain your answer.

Iron (III) Chloride ($FeCl_3$) should be most effective at lowering the freezing point of water assuming that it dissolves to the same extent as calcium chloride and sodium chloride. This is due to its 1:3 cation-to-anion ratio, which produces four separate particles when dissolved — one iron and three chloride. This is a greater number of particles than either calcium chloride (3 particles) or sodium chloride (2 particles).