What is the octet rule?	The concept that atoms tend to have eight valence electrons in their outermost (valence) shell. Atoms react to lose or gain electrons, with the goal of achieving an octet.
Why do atoms tend to lose or gain as few electrons as possible?	Because doing this takes less energy.
What is an ion?	An atom that has an uneven number of protons and electrons. It has either a positive or negative charge. **Cations** have fewer electrons than protons, and therefore have positive charges. Most metals form cations. **Anions** have fewer protons than electrons and therefore have negative charges. Most nonmetals form anions. Many ions achieve the octet. However, some are stable without it (this tends to happen with the transition metals). Ions and their "parent atoms" have different properties because they have different numbers of electrons, which determine chemical properties.
When do ionic bonds (attractions) occur?	Atoms that only need to lose a small number of electrons to achieve the octet are inclined to "donate" their electrons, to atoms that only need to gain a small number. After the electrons transfer, both atoms become ions. They have opposite charges, and therefore attract one another.
Why are ionic bonds often disassociated when ionic compounds are dissolved in water?	The polar (δ) charges of the water molecules interfere with the ionic attraction.
What is a salt?	Any ionic compound.
How is a salt formed? (using NaCl as an example)	1. **Vaporize** solid reactants. For an ionic bond to form, both components must be in gaseous form because the molecules of a gas move very rapidly and collide with other atoms at a speed that allows these reactions to occur. This step is **endothermic** because energy is needed to cause Na to move from a solid to a liquid state. **Na(solid) + Energy → Na(gas)** 2. **Ionization energy.** This energy causes the reactant to give up an electron. Energy is inserted, so this step is **endothermic**. **Na + Energy → Na^+e^-** 3. **Break apart** diatomic reactant. As a diatomic molecule, these two atoms have fulfilled their octet needs and are not reactive. Only when this molecule is broken apart will they be willing to accept extra electrons and form ionic bonds. Energy is needed to break the bond between them, so this is an **endothermic** step. **Cl_2 + Energy → Cl + Cl**

	4. **Electron affinity.** An electron is donated and attached to the other reactant to form an ion. Energy is given off in this step, as the atom accepts the electron and fulfills its octet needs, becoming more stable, so this is an **exothermic** process. **$Cl + e^- \rightarrow Cl^- + Energy$** 5. **Lattice Energy.** After the electron has been donated and received, two atoms have fulfilled their octet needs, but they are left with charges. Being oppositely charged, they attract one another. They end up forming a crystal lattice shape. Because this process neutralizes their charges and renders them more stable, it is **exothermic**. The greater the difference in charges between the two ions, the greater the energy release. $Na^+ + Cl^- \rightarrow Na^+Cl^- + Energy$ The entire ionization process is almost instantaneous. It is, overall, an exothermic process, because the net energy output is much greater than the energy input needed to start the process.
What are the properties of ionic compounds?	• Neutral • High melting and boiling points • Solid at room temperature • Conduct electricity in liquid for or solution • Higher charged ions form stronger bonds • Hard and brittle • Form a crystal lattice
What is the crystal lattice?	The way that ions arrange themselves in crystals. Anions and cations are always surrounded by the oppositely charged ion. There are three basic types of crystal lattices: • Simple cubic • Body centered cubic • Face centered cubic
What is a unit cell?	The smallest component of the crystal lattice (repeated over and over to make the entire lattice).
Why do ionic compounds have high melting and boiling points?	A high amount of energy is required to make the components of an ionic compound break out of the crystal lattice.
Why do ionic compounds only conduct electricity in liquid form or in solution?	When ionic compounds are in solid form, they are in the crystal lattice. Cations are stuck to anions on every side, and anions are stuck to cations on every side. When electricity is introduced, it is attracted to the cations. However, once it goes to one cation, it cannot move to another, because the anions are in the way. The electricity cannot flow through the crystal lattice. In solution or in liquid form, the ions are not locked into the

	crystal lattice and electricity can flow freely. Electricity can also flow through the gaseous form of an ionic compound. However, ionic compounds only become gasses at incredibly high temperatures, so they are almost never gasses.
Why are ionic compounds hard and brittle?	When a force is applied to something, its atoms are moved. When force is applied to the crystal lattice, it forces cations to come near cations and anions to come near anions. However, because of their charges, these ions repel powerfully, causing the compound to break.
How are cations named?	The name, plus the word "ion". Example: Sodium Ion
How are anions named?	The name, minus some letters, plus the suffix "ide" Example: Oxide
How are ionic compounds named?	The cation, minus the word "ion" is named before the anion. Example: Sodium Oxide
What is an oxidation number?	The number assigned to the ion to show the number of electrons lost or gained.
What happens if the cation is a transition metal?	Transition metals often have several different ions, with different oxidation numbers, for each element. When that is true, the oxidation number must be given in Roman numerals in parenthesis. Example: Iron (II) Oxide
How are ionic formulas determined?	1. Write the symbols of the ions, beginning with the cations. 2. The overall charge of the ion must be neutral- this is the principal of electroneutrality. Therefore, all of the electrons must be put into octets and all of the octets must be filled. To do this, find the lowest common multiple of the two oxidation numbers. The factor that reaches this multiple will be the number of atoms in each ion. Example: $\mathbf{Fe^{3+}O^{2-}}$. Fe^{3+} has three extra electrons, while O^{2-} needs two more. The lowest common multiple of 2 and 3 is 6. The number of electrons multiplied by the number of atoms in each ion should equal six. In the case of Fe, 2*3 is 6, so there are 2 Fe atoms. In the case of O, 3*2 is 6, so there are 2 O atoms. This gives each Fe six extra electrons, and gives O a need for 6 electrons. These two charges balance one another out as the electrons are properly distributed. The formula is $\mathbf{Fe^{3+}_2O^{2-}_3}$. 3. Reduce subscripts to the lowest whole number ratio. 4. Include the oxidation numbers of transition metals.

<table>
<tr><td></td><td>Example: Iron (III) Oxide is $Fe^{3+}O^{2-}$</td></tr>
<tr><td>What is done if there are equal numbers of atoms?</td><td>No atom number is given.</td></tr>
<tr><td>What is done if the oxidation number of an ion is +1 or -1?</td><td>No oxidation number is given.</td></tr>
<tr><td>What is a polyatomic ion?</td><td>An ion that is made up of two or more atoms- really a molecule that acts as an ion. It has an overall charge, spread over several bonded atoms.</td></tr>
<tr><td>How are polyatomic atoms named?</td><td>Give the oxidation number of transition metals.
Write the number of polyatomic ions outside parenthesis.
Several prefixes and suffixes are used.
The word hydrogen is used to indicate the presence of hydrogen.
The prefixes mono and di are often used, especially related to hydrogen.
Ions with more oxygen (than other ions of the same elements) take the suffix ate and those with less oxygen take the suffix ite.
The prefix thio is used when a sulfur is replaced with an oxygen (in comparison to otherwise similar ions).</td></tr>
<tr><td>Ions to memorize:</td><td><table>
<tr><th>Ion Name</th><th>Formula</th></tr>
<tr><td>Ammonium</td><td>NH^{+}_{4}</td></tr>
<tr><td>Carbonate</td><td>CO^{2-}_{3}</td></tr>
<tr><td>Chromate</td><td>CrO^{2-}_{4}</td></tr>
<tr><td>Cyanide</td><td>CN^{-}</td></tr>
<tr><td>Hydroxide</td><td>OH^{-}</td></tr>
<tr><td>Nitrate</td><td>NO^{-}_{3}</td></tr>
<tr><td>Nitrite</td><td>NO^{-}_{2}</td></tr>
<tr><td>Phosphate</td><td>PO^{3-}_{4}</td></tr>
<tr><td>Sulfate</td><td>So^{2-}_{4}</td></tr>
<tr><td>Sulfite</td><td>So^{2-}_{3}</td></tr>
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