Charged! – An Ionic Board Game

Overview: The game is designed to increase a student's knowledge of ionic compounds. The game applies the concepts of ionic charges, formulas for binary ionic compounds, as well as the formulas and charges of polyatomic ions.

During the game, each player must combine randomly-drawn tiles representing metals and nonmetals in such a way as to form the correct formula of an ionic compound. In order to do this, players must be familiar with the charges that the most common metals and nonmetals form. Players will also use and increase their knowledge of the correct formulas and charges for a variety of polyatomic ions (see end for a list of polyatomic ions accepted by the app).

Play (for 2 to 4 players or teams)

Each player receives ten randomly-assigned tiles representing various metals and nonmetals from the periodic table. Players must use these tiles to create the formula of an ionic compound on the board. If the formula is correct and accepted by the app, the players will be awarded points and receive more tiles so that the player has ten tiles at the end of their turn.

The player going first must use the central square for the first formula. Subsequent players must use at least one tile in a previously-played compound in their formula following the rules of play described below. Alternatively, a player may use a red tile to play a formula, using the red tile as a buffer tile between a previously-played tile and the new formula (see Using Red Tiles).

The winner of the game is the player with the highest score at the end of the game. The game ends when one player uses all of their tiles or every player passes on their turn.

Rules of Play

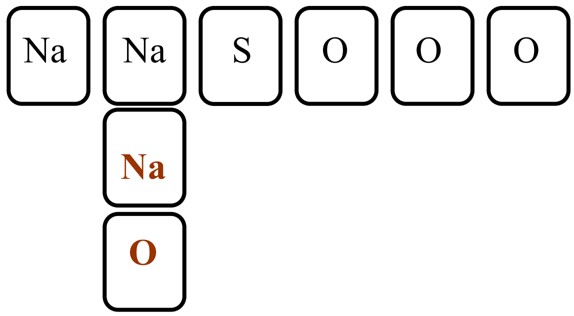
All tiles played must be placed either in the same vertical column or same horizontal row. Tiles may not be played diagonally, or in different rows and columns in the same turn.

Cations must be placed first (or above) in the formula and anions second (or below a cation) in each compound played. For example, sodium nitride, Na_3N, will appear as NaNaNaN on the board. For binary ionic compound, all of the cations must be the same and all of the anions the same.

When a polyatomic anion is played, the elements in the polyatomic anion must appear on the board in the order in which they appear in the formula (which is normally the less electronegative element first). For example, the formula for sodium cyanide will appear as NaCN on the board. For polyatomic ions in which there is more than one of the same element, the tiles for these elements must all be adjacent to one another. For example, in the compound potassium nitrate, KNO_3, the tiles must appear in the order KNOOO on the board. The N tile must be placed before the three O tiles in the polyatomic nitrate ion.

Due to the limitations of the design of the game, compounds that require parentheses are not playable. For example, magnesium nitrate, $Mg(NO_3)_2$ **cannot** be played whereas KNO_3 is possible, as previously shown.

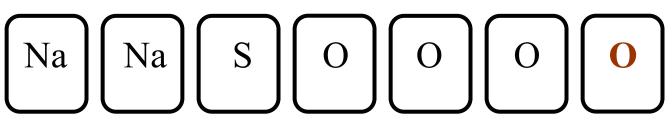
Players may form new compounds using tiles on the board in several ways. One method is to use a previously played tile as part of a new formula running perpendicular to the original formula. In the example below, the first player has formed sodium sulfite, Na_2SO_3, going across.



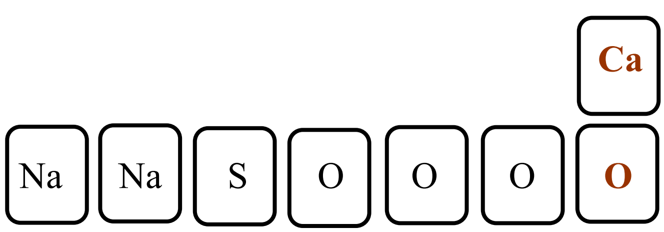
The next player has used the second Na tile to form Na_2O going down (the added tiles are shown in red). Either of the two Na tiles could have been used by the second player.

A player may extend a formula already on the board by adding one or more tiles to the end of a compound. One strategy is to place one or more oxygen tiles at the end of polyatomic oxide provided the new polyatomic ion exists. For example, a hypochlorite anion, ClO^-, may be converted to either a chlorite (ClO_2^-), chlorate (ClO_3^-), or perchlorate (ClO_4^-) anion by adding one, two, or three more oxygen tiles respectively. However, the charge on the modified polyatomic ion must be the same as the charge on the original ion.

In the example below, a player has added an O tile to the end of the formula of sodium sulfite to create sodium sulfate. This is permissible because both sulfite and sulfate have the same charge.

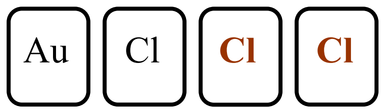


Alternatively, a player may use an added tile to form a new compound. For example, instead of adding only an oxygen tile as shown in the previous example, a player may form a new complete formula using the oxygen tile. In the example below, a player has formed CaO by playing both a Ca tile and an O tile, where the O tile is used to extend the formula of the previously played polyatomic ion.

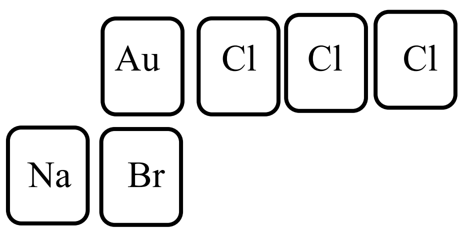


Using transition metal tiles: Tiles for three different transition metals (copper, iron, and gold) are included in the game. All three of these metals can have two different charges, making them more flexible to play. The acceptable charges are Cu^{+} and Cu^{2+} for copper, Fe^{2+} and Fe^{3+} for iron, and Au^{+} and Au^{3+} for gold. If a player tries to form a compound that doesn't correspond to these charges, the formula is considered incorrect.

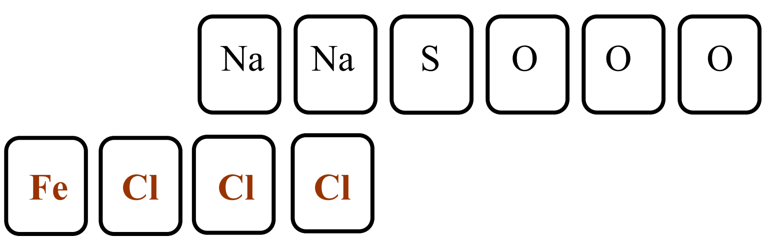
A formula already on the board that contains a transition metal cation may be one charge vertically and a different charge horizontally. Also, the formula containing a transition metal that has already been played may be changed to the higher oxidation state by playing addition tiles to the end of the formula. In the example below, a player has converted the originally-played gold(I) chloride to gold(III) chloride by placing two more Cl tiles at the end of the formula.



This is allowed even if the transition metal tile is part of another formula that requires it to be in the first oxidation state. In other words, a transition metal tile can have one oxidation state horizontally and a different oxidation state vertically. In the example below, gold is being used as Au(I) in the vertical, but Au(III) in the horizontal.



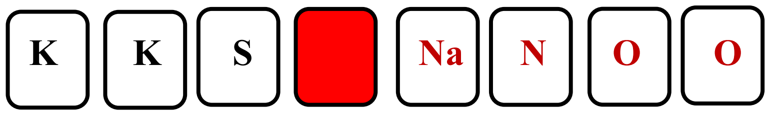
Players may also use more than one tile in a previously played formula. In the example below, a player has used both of the sodium tiles in the previously-played Na_2SO_4 to play iron(III) chloride, also forming two NaCl formulas in the process.



Instead of playing a compound during a turn, players have the option of swapping some or all of their tiles for new randomly-assigned tiles.

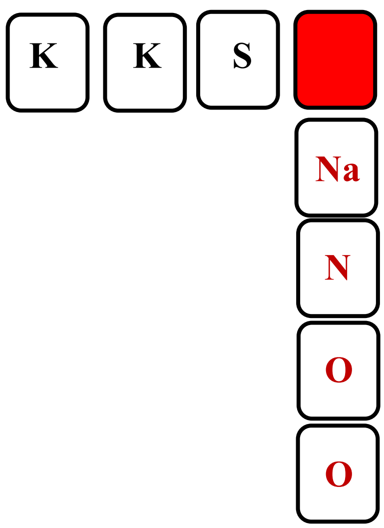
Using red tiles: There are six red tiles that may be used to start a new compound. A red tile must be played adjacent to a tile already on the board. The red tile acts as a blank buffer tile between two formulas or tiles. However, a red tile does not affect the score of the player using it, even if placed on a colored square. In other words, a red tile does not increase a player's score even if it is placed on a double formula (DF) or triple formula (TF) space. Red tiles have no point value, and thus they do not provide any additional points for the player.

In the example below, a player is using a red tile as a buffer tile between the previously-played K K S and the new formula Na N O O.



A red tile must be played adjacent to any tile already on the board. The new formula can be played horizontally or vertically, but all of the tiles in the new formula must be in the same row or column as the red tile.

For example, the formula for $NaNO_2$ in the example above could have been played vertically as long as all of the new tiles placed on the board (including the red tile) are in the same vertical column, as shown below.



Other players may use the other sides of a red tile already on the board for new formulas. For example, the next player could use either the top side or the right side of the red tile in the example above to start a new formula.

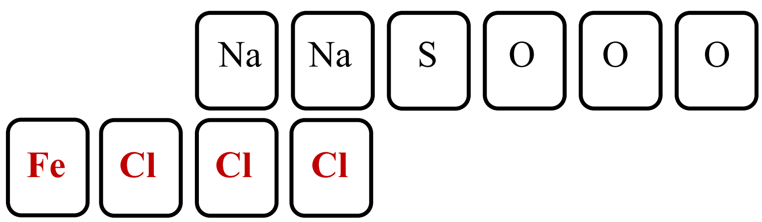
Red tiles are useful for opening up different regions of the board. Subsequent players can also use a previously-played red tile to start an independent compound.

Scoring

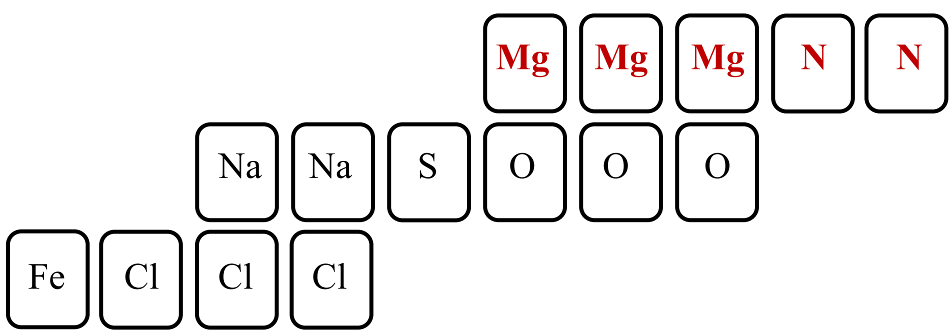
Players that form a compound correctly during their turn are awarded points for each tile in their formula. An element tile is worth the number of points that corresponds to the period number of that element in the periodic table. For example, C, O, and N tiles are each worth 2 points because they are in period 2. Whereas Na, Mg, Al, S, P, and Cl are each worth 3 points each. For example, magnesium oxide (MgO) is worth 5 points (3 + 2) total and sodium oxide (Na_2O) is worth 8 points (3 + 3 + 2) total. Red tiles have no point value.

The board has green double symbol (DS) squares and yellow triple symbol (TS) squares. Tiles played on these squares will have their point values doubled or tripled. There are also blue double formula (DF) squares and red triple formula (TF) squares on the board. The total value for a formula played on one of these tiles will be doubled or tripled.

When multiple new formulas are formed by a player, the points for each new formula are totaled. In the example below, a player has played $FeCl_3$, also forming two NaCl formulas in the process. The player receives a total of 25 points: 13 points for $FeCl_3$ and 6 points for each NaCl. In other words, players receive credit for all compounds formed or modified during their turn.



The next player could use all three of the previously-played O tiles to play magnesium nitride (Mg_3N_2) vertically, as shown below.



Winning the Game

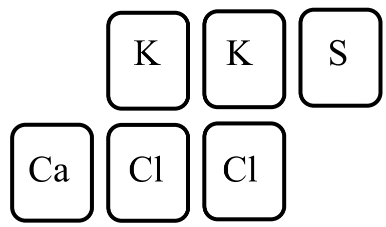
The player that has the highest score at the end of the game wins. The game ends when one of the players uses all of their tiles or when each player passes on their turn. No points are deducted for any unused tiles that a player has once the game has ended.

Strategies

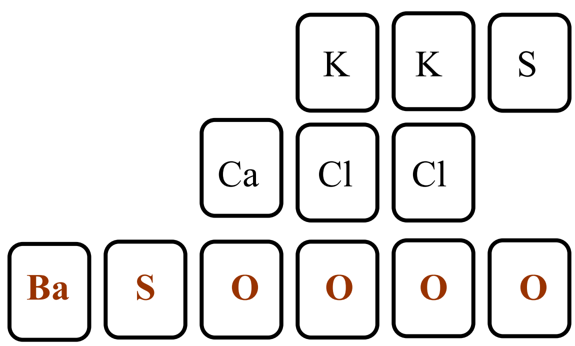
Use oxygen tiles to modify or create multiple polyatomic ions in a single turn. For example, a KCl on the board can be extended to KClO, KClOO, KClOOO, or KClOOOO.

In the example below, a player used the tiles for barium sulfate, **Ba S O O O O**, to form three new formulas going down: CaO, KClO, and a second KClO.

before:



after:



Even without any doubling or tripling, this play is worth a total of 41 points: 17 points for $BaSO_4$, 6 points for CaO, 9 points for KClO, and 9 points for the second KClO.

Carbon tiles are the most difficult to use as they are only used in two formulas; cyanide and carbonate. The phosphorous tiles are also difficult to play. Aluminum is the most difficult metal tile to play.

Oxygen tiles and transition metal tiles are the easiest to use.

Red tiles are very useful for opening up a new region of the board.

The highest-scoring metal is barium (6 pts) and the highest-scoring nonmetal is iodine (5 pts). These tiles are used most effectively on triple score squares or in triple formula plays.

Tiles Included:

Cations	Anions
24 Na (3 pts)	32 Cl (3 pts)
12 K (4 pts)	4 Br (4 pts)
8 Mg (3 pts)	2 I (5 pts)
6 Ca (4 pts)	6 C (2 pts)
2 Ba (6 pts)	50 O (2 pts)
4 Al (3 pts)	12 N (2 pts)
6 Fe (4 pts)	4 P (3 pts)
8 Cu (4 pts)	10 S (3 pts)
4 Au (6 pts)	

6 red tiles (0 pts)

Charges on Monatomic Ions

Main-Group Cations:

Na^{+} sodium	K^{+} potassium	
Mg^{2+} magnesium	Ca^{2+} calcium	Ba^{2+} barium
Al^{3+} aluminum		

Transition Metals: Fe^{2+} and/or Fe^{3+} Cu^{+} and/or Cu^{2+} Au^{+} and/or Au^{3+}

Anions:

N^{3-} nitride	P^{3-} phosphide	
O^{2-} oxide	S^{2-} sulfide	
Cl^{-} chloride	Br^{-} bromide	I^{-} iodide

List of Polyatomic Ions Accepted by the *Charged!* App

N_3^{-} azide			
CN^{-} cyanide			
NO_2^{-} nitrite	NO_3^{-} nitrate		
CO_3^{2-} carbonate			
SO_3^{2-} sulfite	SO_4^{2-} sulfate		
PO_3^{3-} phosphite	PO_4^{3-} phosphate		
ClO^{-} hypochlorite	ClO_2^{-} chlorite	ClO_3^{-} chlorate	ClO_4^{-} perchlorate
BrO^{-} hypobromite	BrO_2^{-} bromite	BrO_3^{-} bromate	BrO_4^{-} perbromate
IO^{-} hypoiodite	IO_2^{-} iodite	IO_3^{-} iodate	IO_4^{-} periodate