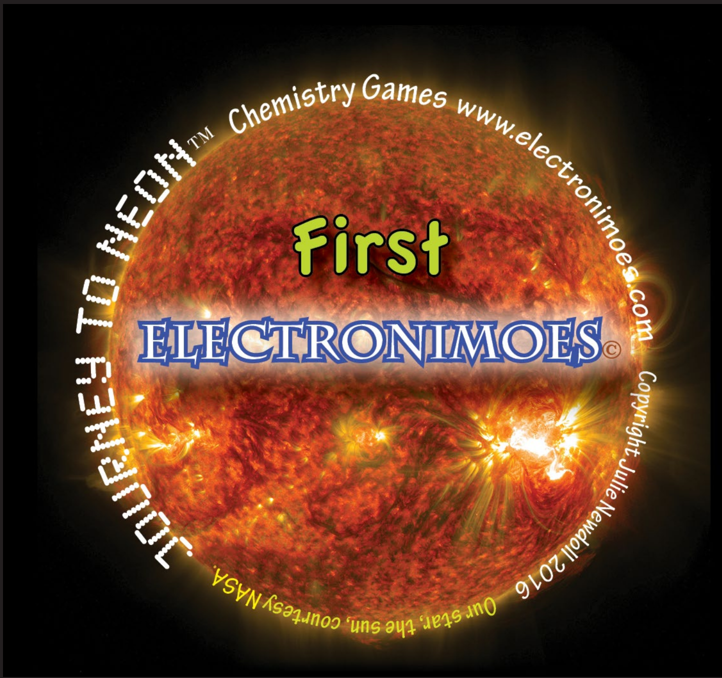

Molecule Emporium

and other chemistry games

you can play with

First Electronimoes©

Circular Atom Cards

These circular atom cards give players a visual way to explore chemical bonding. The games described are not difficult to play, and no prior knowledge about atoms or chemistry is required.

60 min. 12+ 2-4 players

www.electronimoes.com Copyright 2016 Julie Newdoll

Contents

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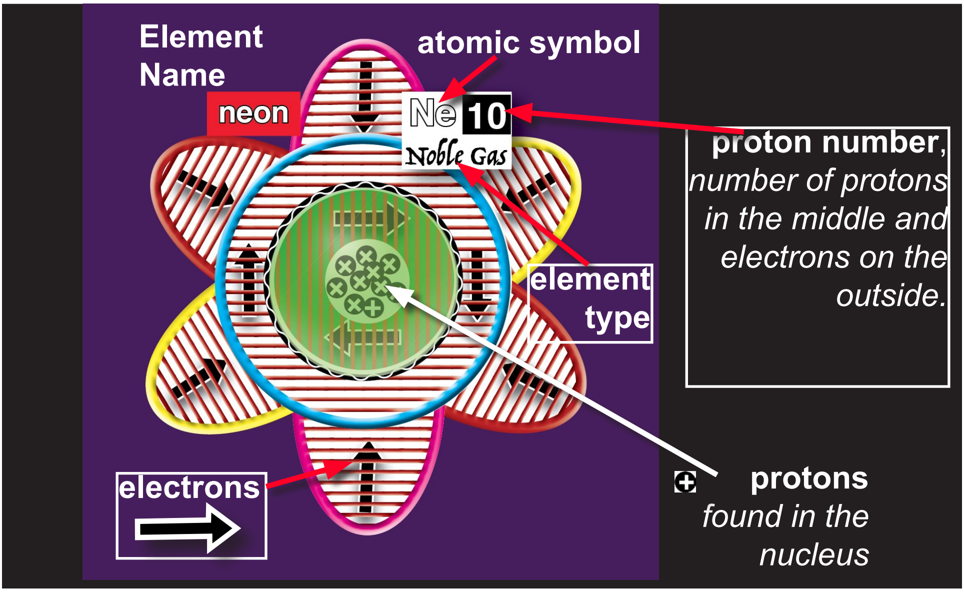
Made in USA
Part of the
JOURNEY TO NEON™
Chemistry Game Series
www.electronimoes.com

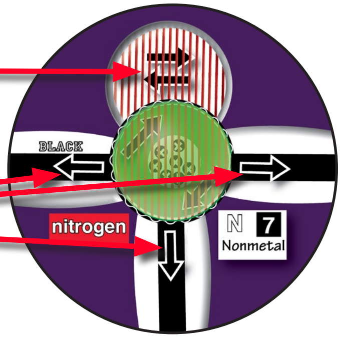
The coolest thing about these cards is that they are easy to match using color and shape, yet through play you are learning how atoms bond together.

What are Electronimoes©?

Each card in this deck represents an atom. Everything is made of atoms, and they are very small. Even special, very powerful microscopes can only give you a fuzzy impression of atoms. Atoms are three dimensional. Electronimoes© show the parts of the atom on a very large scale. They are symbolically represented with shapes and colors. The cards show the electrons, represented as arrows, because this is what you mainly look at when deciding what kind of bonds an atom can make. Protons are represented as plus signs in the middle of the atom. The number of protons tells you what element your atom is. One atom of gold and one of silver, for example, have different numbers of protons in the center, making them different elements.



The protons and electrons you see labeled here are made of ***even smaller*** particles! In reality, protons are much larger than electrons. The protons, electrons, and the spaces between them are not to scale, in part because if they were, the smallest card would have to be around 636 feet, or 194 meters wide! When the arrows are behind red bars, they are part of a pair. They are not available to make bonds in this arrangement. If they point away from the atom, they are looking for an electron partner! Electrons always like to be in pairs. This is why atoms make bonds. Electrons are the glue that bond atoms together. Neutrons are not shown (see page 19 for why).



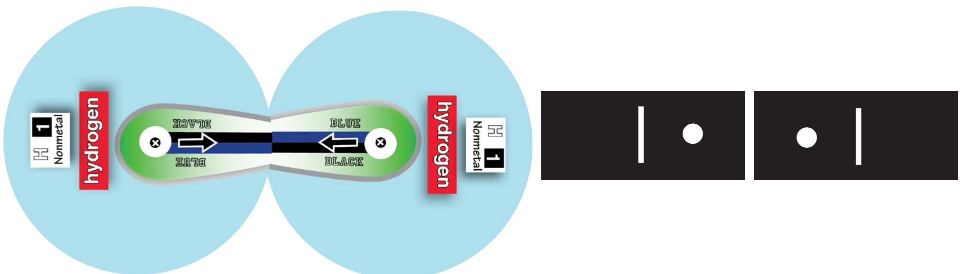
Components

- 96 3.5 inch diameter custom cards
- Packs of 25 play money bills in the amounts of \$1, \$5, \$10, \$20, \$50, and \$100.
- Four paper screens.
- One full color 20 page manual.
- Sturdy deluxe game box.

How the cards fit together

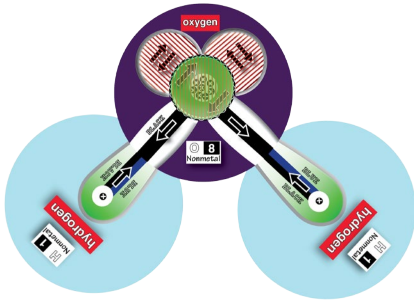
1. **Sharing Bonds (called covalent bonds in chemistry)**

Atoms can share electrons. Like the dots on a domino, if there is only one electron arrow pointing away from the atom in a particular direction along a bonding line, it must match a card where a bonding line also has one electron. Unlike dominos, there must also be at least one color in common on the bonding line between the two atoms. Two hydrogen atoms bond like this, for example:

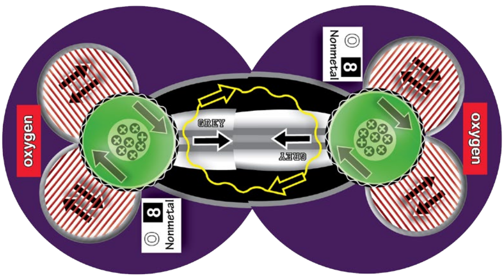


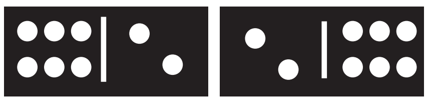
A pair of electrons, two arrows, are being shared by the two atoms. In the case of hydrogen, both lines are black and blue, so they share two colors and are a fine match. For clarity, and for those who might be color blind, the colors are also written in English. If all bonds are the same color on an element card, only one of the bonds will have the color written next to it.

As an example, oxygen can bind to two hydrogens to make water, or H_2O. Notice the line on the oxygen side of the bond between hydrogen and oxygen is black. This is fine, because hydrogen has a line that is part black. As long as the two lines are of the same type and share *at least one* color, it is a good match in the cards.

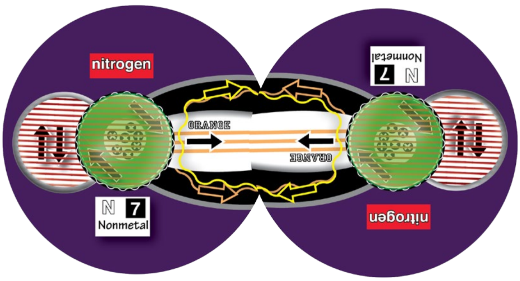


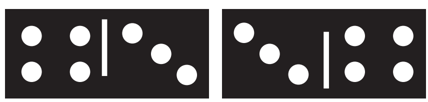
Atoms can share either one, two, or three pairs of electrons in these cards. Two atoms of oxygen can bond together to form O_2, or the oxygen gas we breathe. Two pairs of electrons are being shared in this *double* bond; one in the center on the double grey line, and another pair around the outside of the bond on a wavy yellow line.





Triple orange lines are a match. Find all three pairs of electron arrows in N_2, or nitrogen gas. This is called a *triple* bond.

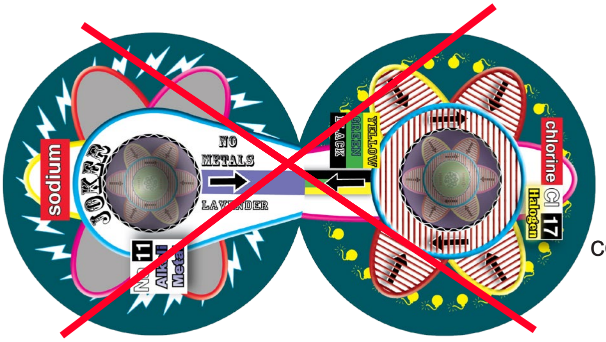




There are the same number of dots on the dominos as there are electron arrows on the molecules in the example above. Count them and see!

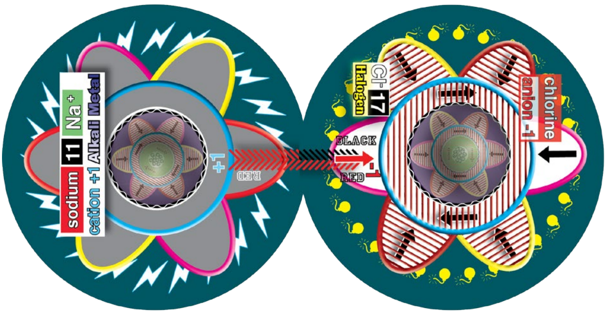
2. **Stolen Electron bonds (called ionic bonds or ionic attractions in chemistry)**

Some elements do not share their electrons. One atom will steal an electron from another. The colors do not match on the sodium and chlorine cards here:



No
colors do not match.

The cards you use to bond sodium and chlorine together, to make a molecule of NaCl, or table salt, have a different kind of line. It looks a bit like the tail of an arrow:



Yes
colors match.
Red on both

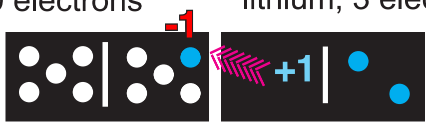
When put together, the lines on these cards are ***pointing the same direction***, making a path from sodium to chlorine. This is because the electron arrow is being stolen from sodium by the chlorine. Notice that an electron is missing from the sodium card, called the "sodium cation" card, and has been replaced by a +1 symbol.

Each electron has a negative charge, while each proton has a positive charge, making the total charge neutral in an intact atom. The attraction between the positive protons and the negative electrons keeps the atom from falling apart! When an atom gains or loses an electron, it is no longer neutral and will have either a plus (missing electron) or minus (extra electron) charge. Anion cards have extra electron(s), while cation cards are missing electron(s). *See page 19 for more information.*

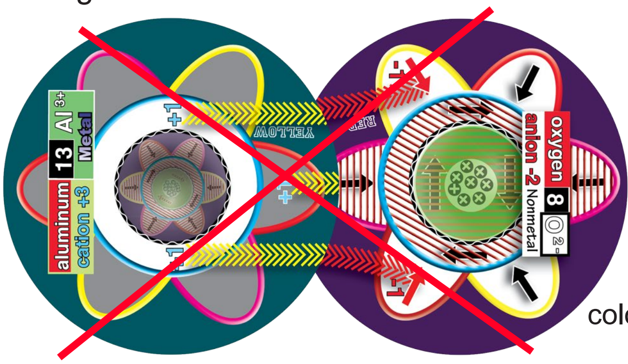
Follow the red path and you will find the missing electron arrow on the "chlorine anion" card. When an atom has an extra electron, it is always red and a **-1** appears next to it in the cards. The word "RED" refers to the color of the line, not the electron.

The domino metaphor breaks down here, because dominos do not steal dots from each other! But if they did, it might look like this:

fluorine, 9 electrons lithium, 3 electrons



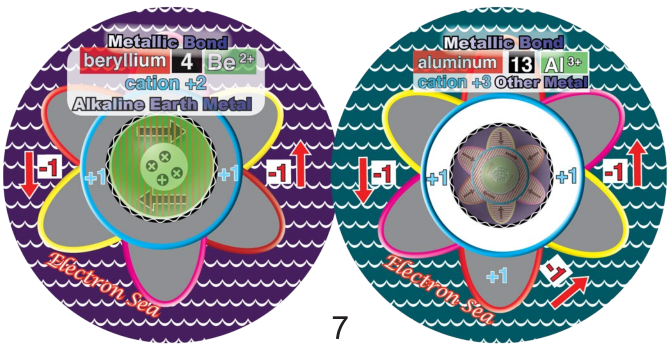
If both cards have this type of line but do not share a color, they are not a good match. Aluminum and oxygen have the right kind of line but the wrong colors.



No
colors do not match.

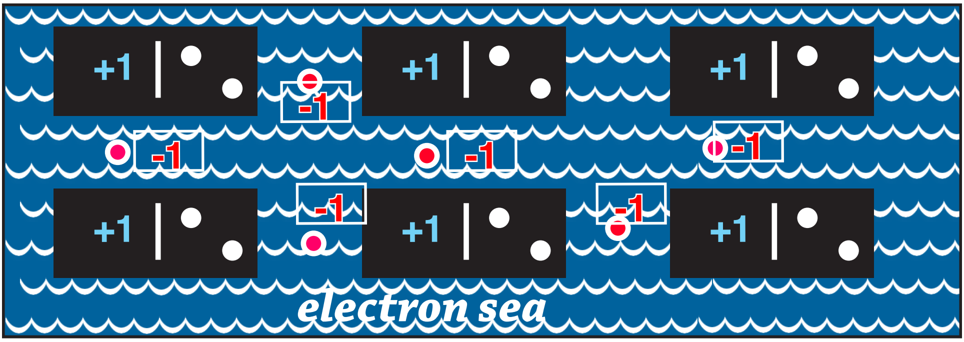
3. **Metallic Bonds**

A third type of bond in the cards is the metallic bond. These cards have a wave pattern in the background. They are labeled with the words "Metallic Bond", and may only be matched with other cards of this type. These atoms are elements which are considered metals. Metals are said to give their outermost electrons to an ***electron sea*** when they bond together. By giving up electrons,



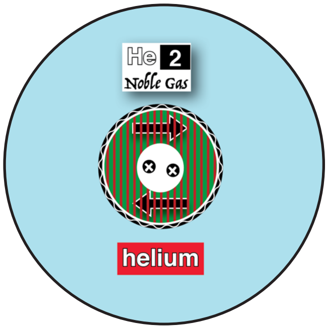
the atoms become positively charged. Notice the +1 signs on the two cations, beryllium and aluminum. A -1 is next to the electrons they have given up, which have entered an electron sea surrounding the atoms. The attraction between the negative electron sea and positive cations keep the metals together.

If dominos could loose their dots, a metallic bond made out of lithium dominos (three electrons, three dots) might look something like this, where the red electrons were the ones that had departed from the domino to enter the electron sea:



4. **Noble Gases**

Some atoms do not bond to anything under normal conditions. These are called noble gases, and all of their electrons are already in pairs. Helium is one such atom:

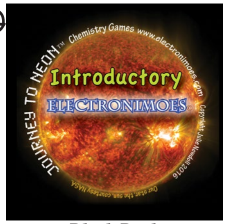


When both electrons are already in a pair, a red grid of lines indicates that they are locked up so not available to make bonds. When all pairs of electrons are locked up this way, you have a noble gas. This card would give you points when played all by itself.

5. **Other Bonds**

These introductory cards may not be able to make your favorite molecule, especially if it is not a neutral molecule. Lithium, for example, can bond to silicon and other elements in ways that are somewhere between the bond types above. Such lithium compounds are useful for making batteries. Try the more advanced decks to make important acids like sulfuric acid, or H_2SO_4; rings of carbon, like benzene; and more.

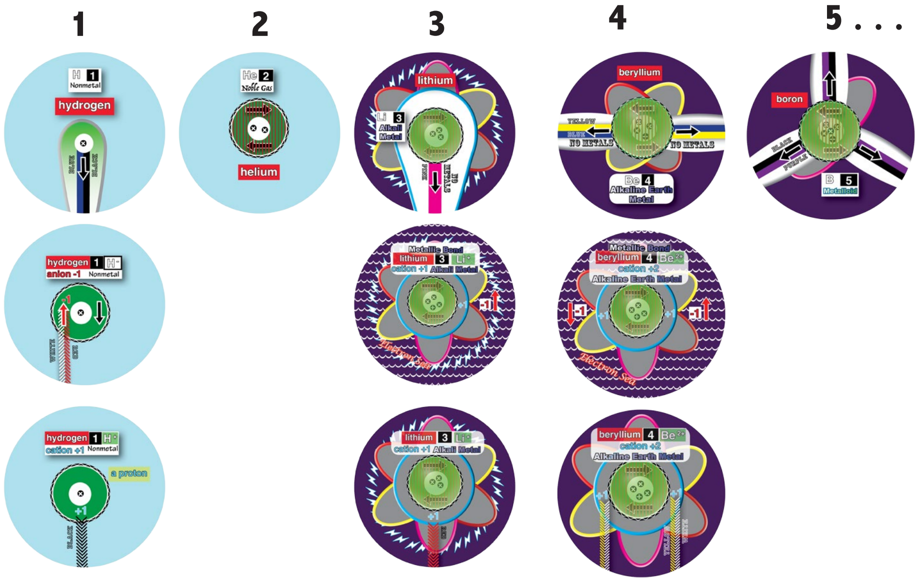
Games using only the deck with the black back - one of each card

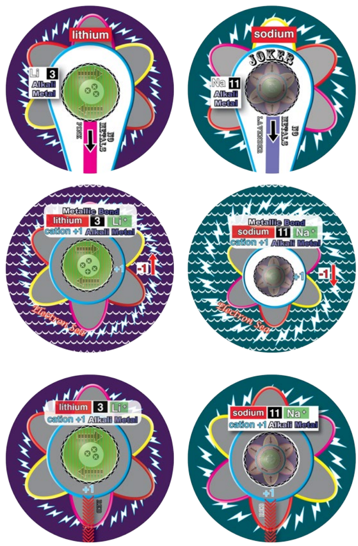


Black Back

Mendeleev's Mind Game

This activity will lead to a subset of the cards you can use to play familiar games like **Go Fish**, **Old Maid**, and **Concentration**. Use only the cards with the black backs. Arrange the cards in columns by their proton number.

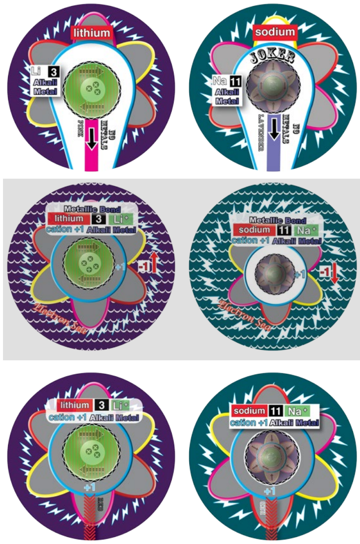




Find the columns with the best match. Column 3 and 11 will be very similar, for example. They will have a different background color, their nuclei will look different, and they might have different colors on their bonds. However, their outermost electrons are arranged in the same manner. This means they will bond to other atoms in similar ways.

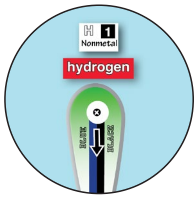
Use the periodic table at the end of this manual to see if you made the right choice. If your two elements are in the same column of the periodic table, you are thinking like the great Mendeleev, who organized the table, in part, so that similar elements were in the same column. **Before you put these cards away, use your card layout to make pairs to play some familiar games using Electronimoes.**

Go Fish, Concentration, Old Maid



In the lithium and sodium example, you should be able to see three pairs. There are two regular, or sharing bond cards; two cation cards; and two metallic bond cards. These are pairs for games requiring them, such as **Go Fish** and **Concentration**. Two noble gases are also a pair. Remove any cards that do not have a best match, as well as all the hydrogen cards, and you are ready to play. Phosphorus and sulfur, for example, have some versions of atoms that can not be made by the smaller elements above them in the periodic table, so they do not have a match in this deck. Oxygen also has a unique card without a matching pair.

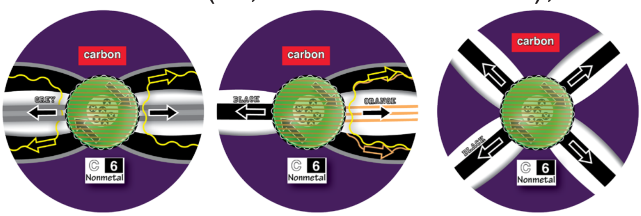
Add the regular, sharing bond, hydrogen card and this deck can be used to play **Old Maid**, where hydrogen is the **Old Maid**. Look up the rules for your favorite card games and try using Electronimoes© to play them.



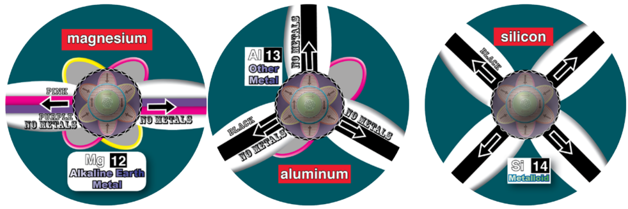
Hydrogen can be the Old Maid.

Gin Rummy

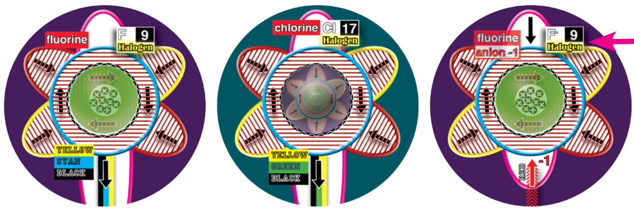
Melds, runs of cards that create a set, could be three or more of the same element (ie., three carbon cards);



three or more cards with consecutive proton numbers, such as magnesium, aluminum and silicon;



three or more of the same category (ie., metals, nonmetals, noble gases, or halogens), notice here the halogen label;



All three cards are halogens, and can be used as a meld or set.

three or more of either cation or anion cards (ie., oxygen anion, nitrogen anion, chlorine anion);

four noble gases, etc. Players determine what other possibilities make a meld, or set of cards, before the game starts. Use your favorite Rummy, Gin Rummy, or even Poker rules, using the above selection of sets of cards.

◇◇

Games using the black and white decks of Electronimoes shuffled together:

First game with both decks - Single Atom!

Object: Be the first player to play all of your cards and have an empty hand. When you only have one card in your hand, you must declare “Single Atom!” First person to play their last card and have an empty hand wins the round. Collect all the points left in the hands of your opponent(s). First player to reach 50 points, or an agreed upon number of points, wins.

Setup

Combine both decks together, those with the white and the black backs, and shuffle. Each person draws a card from the deck. The one with the highest proton number on their card will go first. The dealer will be the person to their right. Replace the cards into the deck and shuffle once more.

Seven cards are dealt to each player, and the top card in the draw deck is placed face up on the ***stack***. On your turn, you place a card with the same name or proton number, or a bonding match as described in the first section. In summary, your card could:

- Have the same proton number / element name (ie. oxygen, or 8)
- A bond on your card has a solid line, as does the card on the stack, with at least one matching color.
- A bond on your card has a double bond, with a grey double line, as does the card on the stack.
- A bond on your card has a triple bond, with an orange triple line, as does the card on the stack.
- A bond on your card has broken arrow lines that match to broken arrow lines on the card on the stack, as well as at least one common color. This means one card will say “anion” and the other “cation”.
- Both cards are metals with Metallic Bond printed on the card, picturing an electron sea full of white waves. There is no color matching required for this kind of card.
- If the card on the table is a noble gas, this is equivalent to a wild card. Any card may be put down.
- If a Joker is played, you may use it as a “reverse direction of play”, or a “skip the next player’s turn” card. The next person to put down a card may put down whichever card they wish.

A player may choose to put down a noble gas as a wild card on their turn, whether or not they can match the card. They may then put down an additional card of their choice to continue the round.

If you can not play a card, you must pick **one** from the draw deck. Play continues in the direction it was going. If the deck runs out of cards before someone has a match, shuffle all but the top card, turn the shuffled cards over as the draw deck, and continue.

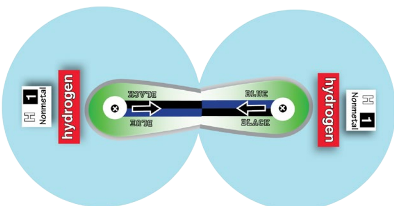
If a player has one card upon discarding, they must declare “Single Atom!” If they do not, on their next turn, they must first draw a card.

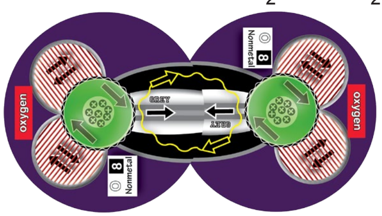
Winning the game
Once someone has run out of cards, the game stops. All players add up the proton points of the cards they have left in their hand. These go to the winner of the round. Shuffle the cards and play another round. First player to reach 50, or an agreed upon number, of proton points, wins!

The game Molecule Emporium
In this game, you are paid by the proton! Make molecules and react them with others to make new ones for the **Molecule Emporium**. Take part in atom auctions, react all the elements you can, and sell off your molecules. **Object:** The owner of the chemical company who earns the most money wins the game.

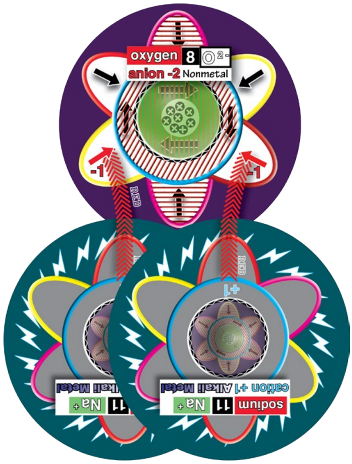
Setup
Combine both decks together and shuffle. Deal each player 11 cards - up to four players. Discard Jokers into chemical storage, or the discard pile. Get out the money from the box. Put up your company sign; either the red, green, blue or yellow paper screen.

Round One - the Emporium is buying
The **Molecule Emporium** is out of stock. Everyone makes as many **complete and neutral molecules** as they can and places them in the center of the table, in the **Molecule Emporium**. Collect a dollar per proton for the molecules you make. These can be**:**
- Noble gases.
- Combinations of cards where all of the electrons are in pairs, and the bonds share at least one color, such as O_2 and H_2:



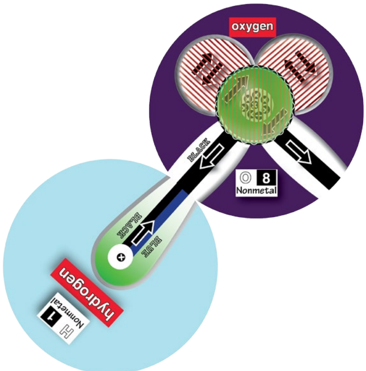


- Cation/anion combinations, where all of the +1 symbols from



the cation cards added to all the symbols from the anion cards are equal, adding up to zero. For example, you would need two sodium cation cards matched with one oxygen anion card to make a complete, and neutral, molecule. Also, both lines are red and they are of the same type going the same direction.

- Two or more Metallic Bond cards together.
- Noble gases are cashed in for their proton number value and set aside in the **Molecule Emporium** chemical storage stack (discard pile).



An incomplete molecule would have one bonding line leading nowhere, like this oxygen attached to only one hydrogen. **No incomplete molecules**!

Each molecule is valued as the total of the proton numbers of all the atoms in the molecule. H_2, or two hydrogen cards bonded together, for example, would only be worth two points. Collect the number of dollars equal to your points for the molecules you made from the **Molecule Emporium** bank. There will now be a selection of molecules in the **Molecule Emporium**.

Round Two and beyond, until the Atom Auction

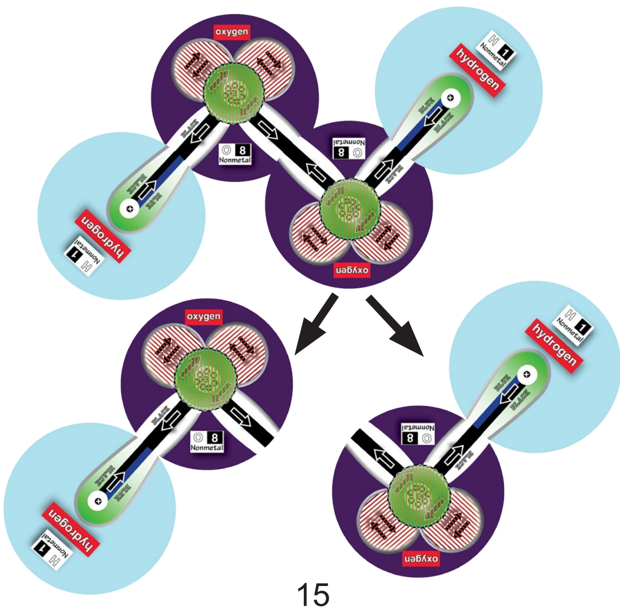
The game is played in rounds.

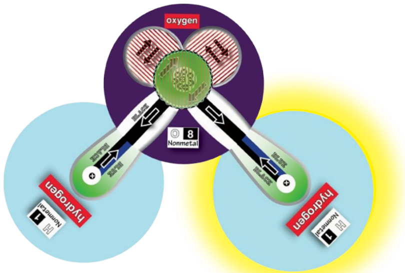
1. Everyone tells the dealer how many cards they need to reach 11 cards again, or five cards, **whichever is more**. The dealer deals out the number of cards requested **face down**. If there are not enough cards to satisfy everyone's request, leave the cards face down and skip to the **Atom Auction**.

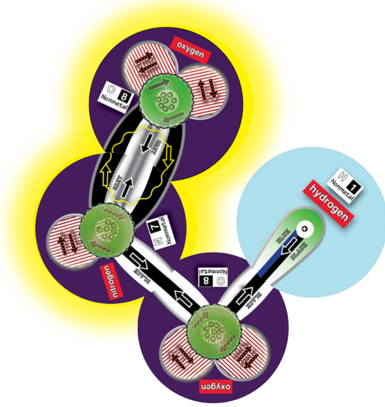
2. The person who will have a birthday next will go first. On your turn, you may buy, sell, or trade atoms with fellow players. If you have any noble gases, cash them in right away for their proton value and place them in the center of the table.

3. You may now put one complete and neutral molecule into the **Molecule Emporium** in exchange for cash OR react with **one** molecule in the **Molecule Emporium** as described below.

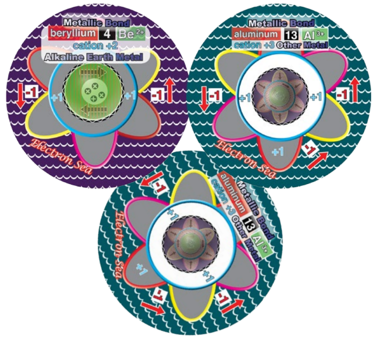
- When reacting some of your cards with one of the molecules in the **Molecule Emporium**, you must end up with no more than two new molecules. First, separate the molecule you wish to react with into two pieces ***without rearranging the cards/bonds between the atoms***. You could divide hydrogen peroxide, or H_2O_2, for example:



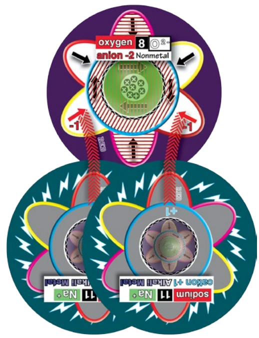




- With your cards, make no more than **two** new complete and neutral molecules. Either one or more cards may be inserted between the two halves, or two new products may be created.
- If you made the NO_2H and H_2O pictured above (the new cards are highlighted yellow) you would add up the proton numbers of **all** the atoms in **both** molecules, and collect this much from the **Molecule Emporium** bank. For the compounds in this example, you would collect $10 for the water ($8 for oxygen and $1 for each hydrogen) plus $24 for NO_2H, or nitrous acid, so $34 total.
- Adding a metal to a group in a metallic bond is also considered a reaction. Collect a dollar per proton in the **entire set** of metallic atoms involved in this new metal alloy you have created.



- Adding an ion to a group of atoms involved in an ionic attraction / bond is also considered a reaction. It must be a complete and neutral molecule, so the same number of +1 and -1 symbols must be present on the molecule. Collect a dollar per proton for the entire ionic compound.



4. If you would rather sell the **Molecule Emporium** ONE complete and neutral molecule for the amount they are worth in proton points, you may do so. Collect one dollar per proton in the molecule.

5. When everyone has had a turn, the round ends with a molecule auction. Everyone has the opportunity to buy molecules that are on the table from the **Molecule Emporium** bank for the face value of the atoms in the molecule added together. If two players want to buy the same molecule, it will go to the highest bidder. If no one wants to buy a molecule, it stays on the table. Purchased molecules may be broken up and added to your hand to be used on your next turn in any way you wish.

6. After everyone has had a chance to buy molecules, any remaining molecules which have more than six atoms are discarded into chemical storage (the discard pile) until the end of the game. Any noble gases are also removed and discarded into chemical storage. Play another round (back to page 15).

Atom Auction!

If there are not enough cards in the deck to deal out five cards, or the amount needed to make 11 cards, for each player, it is time for the Atom Auction. DO NOT pick up any of the cards and put them in your hands.

First, all the molecules in the **Molecule Emporium** are gathered up and placed in chemical storage. Place all the remaining cards that were in the draw deck face up on the table.

1. If there are only two players, the one willing to pay the most for each atom card pays the bank and takes the card. Undesired

cards go to chemical storage (discard pile).

2. If there are more than two people, the person whose turn it was will be the first auctioneer*. The auctioneer will determine the starting bid for a card. This could be way below the value of the card, or higher than the value. Players will bid for the card, and it will go to the highest bidder. The auctioneer may also bid. **If no one buys the card, the auctioneer must pay the current price and take the card**. All proceeds will go back to the bank. Take turns auctioning the atoms until they are all gone.

3. Players take turns being the auctioneer. Once all the atoms have been auctioned off, players will make as many new molecules as they can. Anyone can sell or trade cards at this stage, as well. Each player collects money for the proton value of their molecules once they place in the **Molecule Emporium**.

Winning The Game

After the Atom Auction, the game is over. Each player counts up their money. The chemical company who has reaped the most profits has won the game.

*What is an Auction?

The auctioneer might say, “Fluorine is up for auction! Do I hear $5?” If a player says yes, the auctioneer might say, “I hear $5. Do I hear $6?” This continues until no one will go any higher. Highest bidder gets this atom and pays the bank.

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Would you like to know more?

The bond colors used to help you match cards together are guides based on what is often a good match, according to general rules in chemistry. These rules are sometimes broken in real life, depending on the elements and conditions involved. Important molecules with an extra electron, or missing an electron, are not the focus of these cards. Molecules where the electrons are distributed in more complicated ways may be constructed with the more advanced decks of Electronimoes© (like benzene or polyatomic ions).

Where are the neutrons in these cards? There are ***usually*** around the same number of **neutrons** as protons in the center of an atom. Neutrons are not pictured in Electronimoes© cards, because an atom of a given element does not always have the same number of neutrons as another atom of that same element!

What about the colors on cards like neon? Orbitals, or electron clouds, are considered to be the regions around an atom that a particular electron spends its time. A preview of the color scheme used to describe orbitals in the more advanced cards can be seen on the neon card, and others like it with what are called "unhybridized" orbitals. There are four orbitals in the outmost shell of neon. These are outlined with the colors blue, red, yellow and magenta. The inner shell has one orbital, separated by a wavy line, and is the color green. Each orbital only holds up to two electrons. Get the advanced Electronimoes© decks for more about orbitals.

What are the lightning bolts and bombs about? The elements fluorine, chlorine, sodium and lithium give a preview to the more advanced Electronimoes© decks. They contain symbols around the outside indicating they are easy to steal electrons from (lightning bolts) or very powerful electron thieves (bombs).

The bigger the lightning bolt, the more easily the electron can be stolen and the more reactive an element is. This attribute is called ionization energy. Sodium is more easily ionized than lithium, and so has bigger lightning bolts. Fluorine and chlorine are surrounded by a ring of bombs, indicating an attribute called electronegativity. Highly electronegative elements have the ability to steal electrons, or attract electrons to themselves. Fluorine has the biggest bombs. It is the most electronegative, and the most reactive element in the periodic table!

Credits

Game Concept and Artwork: Julie Newdoll

Resources used to create these cards

Brady, J.E.; Senese, F., ***Chemistry: Matter and its Changes***; 5th ed.; John Wiley & Sons, Inc.: New Jersey, 2009.

Edition by Nivaldo J. Tro, ***Principles of Chemistry: A Molecular Approach***; 3 edition (January 3, 2015) Pearson Publisher.

http://www.chemspider.com and ***pubchem.ncbi.nlm.nih.gov***

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"Julie Newdoll's Electronimoes is an easily learned, colorful game. The bonding combinations that one comes up with in the course of game make sense. They teach beautifully, and even researchers may wonder at what molecules students can make!" -**Professor Roald Hoffmann**, Cornell University, winner of the 1981 Nobel Prize in Chemistry (shared with Kenichi Fukui).

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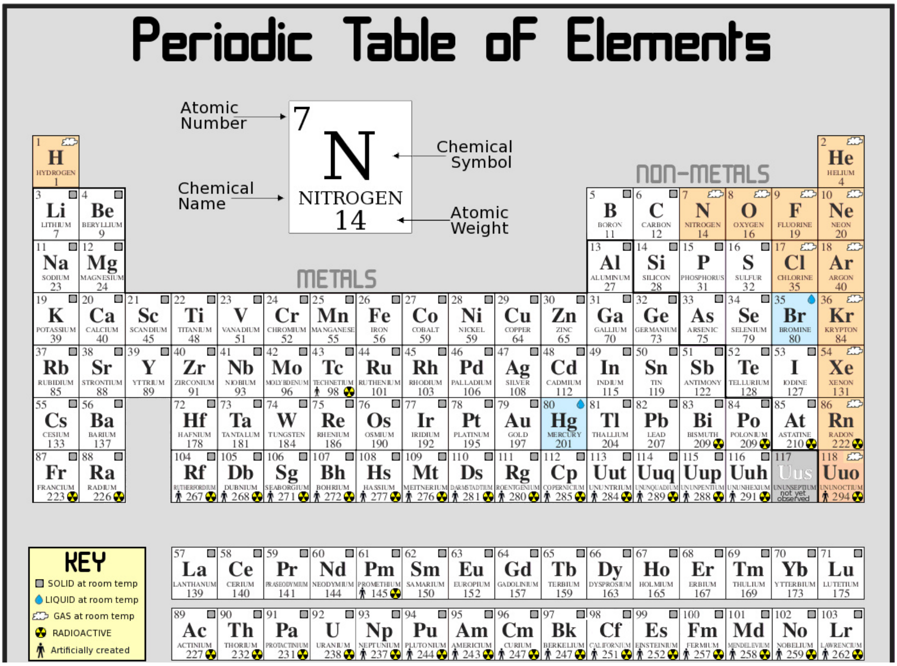

Periodic Table www.wpclipart.com