Chemistry As Fun And Games

An interactive, creative, and fun way to teach chemistry while increasing student engagement and involvement in the classroom.

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Introduction

Session Title: Chemistry as Fun and Games!

Abstract: Explore games as a teaching tool! Experience Nomenclature Football, Ion Poker, Electron Battleship, and more as you consider ways to increase student engagement. Also--People demos!

Description: Games have become an important component of Chemistry at Clayton High School. "Game days" bring increased student engagement and enthusiasm. This session will involve participants in playing many of the games used at CHS. Some topics to be addressed through play will include chemical nomenclature, periodic trends, ionic charges and electron configurations. Others areas will be discussed as time allows, with opportunity provided for sharing and brainstorming among teachers in order to produce new ideas. Additionally, several short "people demos" will be shared. These demos involve students playing roles to illustrate various chemical concepts. They consistently receive favorable feedback from CHS students. The presentation will be "low tech." All participants will leave with ideas they can use in their classroom for almost no cost and just a little effort.

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Chemistry Football

Assumption: The teacher has a rudimentary knowledge of the game of football

Background: The class is divided into two teams. Each team sits in two rows. The teacher will walk between the rows while checking.

Rules:

1. **Offense** gets 4 downs (they may punt on 4th down)

2. **Defense** is checked on each play.

3. **Checking the offense:** Plays can be for 5, 15, or 30 yards. The difficulty level of the question is determined by the yardage attempted. More yardage results in a more difficult question. Each offensive player's answer is checked on each play. Players may not work together. The team is allowed 2 - 3 misses per play (number of misses is determined by the teacher upon consideration of the number of players. Roughly a 30% miss ratio is normal.) While checking the teacher holds up fingers to indicate misses. This makes the game "high pressure."

4. **Checking the defense:** If the offense has more than the allotted number of misses, each defensive player is checked. If the defense has less than the allotted number of misses, the offense loses the number of yards attempted. If the defense also has more than the allotted number of misses, there is no yardage loss or gain, but there is a loss of down.

5. **The blitz:** On any play before checking begins, the defense may call "blitz." A blitz is a "head to head" competition. The team with the most correct answers wins the blitz. If the offense wins, they get double yardage. If the defense wins, the offense is "sacked." If on a blitz the defense gets 100 % correct and the offense has a miss, the result is an interception and the ball is considered to be "run back" to the original line of scrimmage.

6. **The Punt:** 25 - 50 yards. When punting, each team is checked. The following scenarios can arise:

Kicking team wins:	50 yard punt
Receiving team wins:	25 yard punt
Tie:	35 yard punt
100 % correct on receiving team with no tie:	Blocked punt. Take over at line of scrimmage.
100% correct on kicking team with no tie:	Fake punt and necessary yardage for a first down whatever that may be.

7. **Field Goals**: Within 40 yards of the goal. Field goals are checked as head to head competition. If the offense wins, they get the field goal. If the defense wins, they take over at the line of scrimmage.
A tie is a win for the defense. Further distance from the goal requires a more difficult question.

Other notes:

- This game can be used for any question, which results in an easily "checkable" answer. Examples are nomenclature, electron configurations, atomic structure, dot diagrams, bond type, compound type, molar mass, simple mole conversions, periodic trends, etc.
- Dice may be used as a way to determine play calling.
  1 = 5 yards, 3 = 15, 5 = 30 2 = 5 with a blitz, 4 = 15 with a blitz, 6 = 30 with a blitz.
- Penalties may be assessed for excessive noise, etc.
- Uneven numbers of players may be adapted for by alternating counting the number of correct answers instead of incorrect answers.
- Teachers have discretion to change the rules to increase the "fun" factor!

Electron Configuration Battleship

Purpose: To teach students how to look at an element on the periodic table and instantly determine its electron configuration.

Materials: 1 Manila file folder per student, 2 laminated periodic tables per folder, dry-erase or overhead markers (1 per student).

Assembly: Tape the periodic tables to the top and the bottom of the inside of the manila folder, both of them right-side up.

Playing the Game:

- The game is played like traditional battleship in groups of two students. Each student has the manila folder open so that the opponent cannot see either of his/her periodic tables.

- Each player puts a line through the appropriate number of elements to indicate an aircraft carrier (5 elements), a battleship (4 elements), a submarine (3 elements), a destroyer (3 elements), and a PT boat (2 elements). Note: the number of ships can be increased which will create more "hits" and more fun!

- The first player calls a valence configuration for an element of his/her choice. For example, carbon would be $2p^2$. The other player states the name of the element called (in order to verify understanding of the "code" between the players), and then says "hit" or "miss."

- The player stating the configuration marks the top periodic table to note shots taken, and the player being "shot at" marks hits and misses on the bottom periodic table.

- Play continues until all ships are "sunk."

Extensions: The method of stating configurations can vary. For example, Ge could be stated $4p^2$ or $4s^2 4p^2$. Iron could be stated $3d^6$ or $4s^2 3d^6$, etc…

Electron Orbital Game

(adapted from the "World of Chemistry" video)

Purpose: To teach and reinforce the Aufbau principle, Pauli exclusion principle, Hund's rule, and quantum numbers.

Teams: The class is divided into two teams.

Field/equipment: The game may be played outdoors or in a gym.

Meter sticks are used to represent atomic orbitals through the 4p sublevel.

Two atoms are set up which will require 36 meter sticks.

Each player needs an arrow to indicate their spin.

Playing the Game:

The teacher has several options in this game. They include but are not limited to the following:

- State the name of the element and the students go stand in the appropriate orbitals.
- State the name of the element and the students send a representative out to represent the electron in the highest energy orbital.
- State a set of quantum numbers an element's highest energy electron and the students send representatives to represent the element.
- State an element and fill its valence shell only.
- Electron configuration of ions

Notes:

- Arrows must be in opposite directions to get credit.
- Hund's rule must be obeyed.
- A whistle is helpful.
- "Ghost" electrons may be used for the lower energy electrons.

Ion Poker

Purpose: This game is designed to help students learn how to use the periodic table as a tool to determine anion and cation oxidation states.

Materials: Pennies, Index cards with s and p block elements written on them.

Playing the Game:

- Place students in groups of 4 - 5.
- Each student is given 20 pennies. Each penny represents an electron. Electrons are the currency of the game.
- Each student is dealt 5 cards at random. (poker style)
- The dealer begins play by setting down a card of his/her choice. He/she must find the element on the periodic table and determine the number of electrons that element loses or gains when forming an ion. He/she must choose one player with whom to interact. If the element loses electrons, the appropriate number of pennies must be given to that player. If the element gains electrons, the appropriate number of pennies must be taken from that player.
- Play continues to the dealer's left until all cards have been played.
- The object of the game is to obtain as many electrons as possible.

Possible extensions: Add transition elements and/or polyatomic ions.

Marble Madness

Purpose: Students will begin to understand the principle of ionic bonding and electron transfer as they transfer marbles to one another in order to satisfy the conditions stated by the instructor.

Materials: 1 small cup for each students, four marbles for half of the students (the other half of the students get no marbles – just an empty cup)

Set-up: Students who have marbles are told that they are the marble givers while those without marbles are told that they are the marble acceptors. When a giver wants to give a marble to an acceptor he must place the marble in the acceptors cup and then must remain next to the acceptor. When a group of students believe they have satisfied the instructor's conditions, they raise their hands, and the instructor will check to see if they are correct.

Game Play:

1) Instructor shouts out the conditions: e.g. Each GIVER must give 2 marbles; Each ACCEPTOR must accept 3 marbles.
2) Students must begin the transfer process as givers and acceptors interact: e.g. in the scenario students will have to realize that there need to be 3 givers and 2 acceptors in order to satisfy the conditions stated.
3) When a group of students raises their hands, check to make sure they have transferred the marbles correctly: e.g. each of the 3 GIVERS has only two marbles remaining in his or her cup, while each of the 2 ACCEPTORS has three marbles in his or her cup.
4) Discuss with entire class how to arrive at correct grouping of GIVERS and ACCEPTORS.

Notes:

1) This is a great way to begin the discussion of ionic bonding and ionic compound formula writing, and it avoids the dreaded criss-cross algorithm. (However, some students will eventually discover this trick.)
2) Begin with easy conditions: e.g. Each GIVER must give 1 marble; Each ACCEPTOR must accept 1 marble. Then move on to more difficult conditions. A favorite is the give 3 / accept 4 scenario. If students have not yet figured out the criss-cross trick, this one will have their heads spinning.

The Great Mole Relay Race

Purpose: Students will work as a team in a relay race format in order to solve 1-step and multi-step problems involving mass, moles, and representative particles.

Materials: Whiteboards mounted on wall, dry erase markers, slips of paper with different problems printed on each

Set-up: You will want to separate your class into teams of about 3-6 people each. Be strategic in your team formation so that no one team has a lop-sided advantage or disadvantage. Each team will use a different section of the whiteboard.

Place the problems which are on the different slips of paper in cups labeled for each team. Each cup will contain the same five or six problems, but students will choose the slips at random, so that each team will probably be working on a different problem at any particular time.

As teams work out the problems you will want to make sure you have a clear answer key already written out so that you can check their work.

Game Play:

1) On your signal, the first student from each team will pick a slip of paper from his team's cup. He will then write the problem on the board in any form he chooses so long as the rest of his team understands the problem (note: no one else is allowed to look at the slip of paper). Player 1 then sits down.
2) Player 2 then heads to the board and begins the problem, proceeding through the first conversion factor.
3) Player 3 then heads to the board and continues the problem by writing the next necessary conversion factor.
4) Player 4 will write the next conversion factor, or if there is no need for another conversion factor, she must use her calculator to correctly compute the answer with units.
5) Check the answer. If it is correct, the next person may begin the next problem. If it is wrong the next person must go to the board and figure out what is wrong and fix it. This requires each person to be engaged in the whole problem. Require each person to write each problem on his or her own paper. Collect all of their work at the end of the game.
6) The winning team is the one that finishes all of the problems the fastest.

Sample:

Calculate the number of formula units of sodium sulfate present in a 20.0 gram sample.

Player 1: **20.0 g Na_2SO_4 $\rightarrow$?? form. un.**
Player 2: **20.0 g Na_2SO_4 x (1mole / 142.0 g)**
Player 3: 20.0 g Na_2SO_4 x (1mole / 142.0 g) **x (6.02 x 10^{23} f.u. / 1 mole)**
Player 4: 20.0 g Na_2SO_4 x (1mole / 142.0 g) x (6.02 x 10^{23} f.u. / 1 mole) **= 8.48 x10^{23} f.u.**
Player 5: Starts next problem

Notes:

1) You may choose to require all students to remain silent while other students work at the board, or you may choose to allow students to yell out advice (just like The Price is Right). I prefer the louder option. It's just more fun.
2) Feel free to tone down the competitive nature of the game by using different problems for each team, as opposed to each team working on the same problem.

The Great Stoichiometry Relay Race

Purpose: Students will work as a team in a relay race format in order to solve stoichiometry problems.

Game Play: Use the same format as above for stoichiometry problems.

Sample:

If the decomposition of 10.0 grams of water is performed at STP. Calculate the number of liters of oxygen gas that would be produced.

Player 1: **$2H_20 \rightarrow 2H_2 + O_2$ @STP**
10.0g ??L

Player 2: **10.0 g H_20 x (1 mole H_20/ 18.0 g H_20)**

Player 3: 10.0 g H_20 x (1 mole H_20/ 18.0 g H_20) **x (1 mole O_2/ 2 mole H_20)**

Player 4: 10.0 g H_20 x (1 mole H_20/ 18.0 g H_20) x (1 mole O_2/ 2 mole H_20) **x (22.4 L O_2/ 1 mole O_2)**

Player 5: 10.0 g H_20 x (1 mole H_20/ 18.0 g H_20) x (1 mole O_2/ 2 mole H_20) x (22.4 L O_2/ 1 mole O_2)

= 6.22 L O_2

<u>White Board Races</u>

Purpose: Students work individually or in pairs to solve problems at a small whiteboard, while competing against other students.

Note: This requires much less set-up than the relay races and still involves a competitive game format.

Mole Scavenger Hunt

1. While having fun in Chemistry class, you get thirsty. You go down to the "good drinking fountain" (near room 100) to have a drink. You drink for a full minute.

    How many molecules of water did you just drink?
    What was the mass of this water?

2. As you are strolling around the quad area, you trip and fall on a sweet gum ball. (sweet gum tree is near the cottage) You decide that since you tripped that no one else should go away unharmed. You are going to cover each square of sidewalk with these balls touching side by side, leaving no part uncovered. How many squares of sidewalk could you cover with one mole of sweet gum balls?

3. After all this work you are thirsty. You decide that you should have a can of Mountain Dew.

    How many moles of sodium did you just consume?
    How many moles of sugar ($C_{12}H_{22}O_{11}$) did you just consume?
    How many molecules of sugar did you just consume?

4. You have a whole lot of paper to recycle. You will take it directly to the outside paper recycle bins. Assume that you will stack the paper up perfectly and place each stack in the bin with a height no higher than the front opening of the bin. How many recycle bins will you need to throw away a mole of paper?

5. In the front of the school there are two holly bushes. How many bushes would the school have to plant to have a total of one mole of berries? (you are welcome to count part of the bush and estimate to get you started)

6. The school district is insisting on planting a mole of blades of grass. How much space will this take?

7. Again you are thirsty. After you buy a bottle of water from the Fruitworks machine…

    How much did each molecule of water just cost you?
    How many water bottles would you have to purchase to consume one mole of water?

Periodic Table Trend War

Purpose: To teach students periodic trends regarding the properties of elements.

Materials: 1 die, index cards with main group element symbols written on them (one element per card), a list of trends written on the board numbered from 1 - 6. Trends should include such things as ionization energy, electronegativity, atomic radius, ionic radius, etc… A "wild" category can be included which allows the roller of the dice to choose the trend.

Playing the game:

- Students are placed in groups of 4 - 5.
- Cards are dealt until each student has the same number of cards. Each student should have about 7 cards per hand.
- The dealer begins play by throwing the die. The number of the die determines the trend being played.
- After the trend for the hand is determined the dealer plays the first card. Play continues to the left of the dealer. The card with the highest value for the current trend wins. The player who takes the hand rolls the die and makes the next lead. Multiple hands may be played.

Note: This game is based on the card game of "War." Rules may vary at the teacher's discretion.

People Demos

1. Energy Levels:

2. Replacement Reactions:

3. Ion Formation:

4. Polar/Non Polar Molecules:

5. Pi Bonds:

6. Paper Wad Equilibrium:

7. Metallic Bonding:

8. Crystal Lattice Formation:

9. Heisenberg Uncertainty Principle: