2015

Artist as Chemist [10th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: **Artist as Chemist (adapted from** "Artist as Chemist." Active Chemistry. New York: It's About Time, 2003.)

Grade Level: **10th**

Subject/Topic Area(s): **Chemistry**

Designed By: **Bonnie Brawner**

Time Frame: **7-9 weeks**

School District: **Northeast Independent School District**

School: **International School of the Americas**

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Brief Summary of Unit (Including curricular context and unit goals):

The purpose of this unit is for students to experience the interdisciplinary nature of chemistry and science by having them create a work of art using processes and/or concepts learned in class. Each student will create their own art piece which incorporates at least 7 chemical processes. At least 4 of them must be concepts learned in class. The theme of the project is "My Personal Identity." Accompanying the physical project will be a "How-To" paper which explains at least 7 of the chemical processes used to create the art piece. Also, accompanying the project will be a paper explaining the theme – how the project relates to themselves.

This unit should be introduced at the beginning of the year, although it is meant to be completed sometime during the last nine weeks of the academic year. At this time share the rubric and project specifications with the students. Periodically throughout the year, check in with students on project ideas, or how a particular topic of study might relate to the project.

This unit will be very laboratory intensive, and could include 5-8 laboratory activities. It will also cover a variety of chemistry topics, including: acids and bases, solvents, solutions and solubility, reaction types, chemical bonding, and polarity.

Artist as Chemist - UbD

Adapted from "Artist as Chemist." <u>Active Chemistry.</u> New York: It's About Time, 2003.

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="6">Established Goals (e.g., standards)

(C.7) Science concepts. The student knows how atoms form ionic, metallic and covalent bonds. The student is expected to
(D) describe the nature of metallic bonding and apply the theory to explain metallic properties such as thermal and electrical conductivity, malleability, and ductility; Supporting Standard

(C.10) Science concepts. The student understands and can apply the factors that influence the behavior of solutions. The student is expected to
(B) develop and use general rules regarding solubility through investigations with aqueous solutions; Readiness Standard

(G) define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions and predict products in acid-base reactions that form water; Supporting Standard
(H) understand and differentiate among acid-base reactions, precipitation reactions, and oxidation-reduction reactions; Readiness Standard
(I) define pH and use the hydrogen or hydroxide ion concentrations to calculate the pH of a solution; and Supporting Standard

Scientific Process Skills
(C.2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is</td>
<th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will independently use their learning to…
--explain chemical concepts involved in a non-chemistry discipline
--explain chemical concepts involved in creating a work of art
-- incorporate chemistry knowledge and lab skills into creating a work of art</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>Understandings
Students will understand that….
- Chemistry has practical applications that extend across content areas.
- Knowing and applying chemistry concepts can improve our lives in other areas/discipline
- Artists can use chemistry knowledge to create, preserve and protect art</td><td>Essential Questions
- How can chemistry knowledge, principles and skills be used to create a work of art?
- What are the relationships between chemistry and art?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Knowledge
Students will know…
- how acid rain occurs and equations that show formation of acid rain
- the definition for acids and bases and the difference between strong and weak acids and bases
-Arrhenius and Bronsted-Lowry definitions of acids and bases
-definition of valence electrons
- the definition of alloys and several examples
- the difference between a hydrate and anhydrate
-definitions of soluble, insoluble, solute, solvent, polarity, polar, non-polar, solubility</td><td>Skills
Students will be able to…
- develop a piece of art and explain the chemistry behind it
- recognize and name strong acids and strong bases
-calculate pH, pOH, [H+], [OH-]
- predict products for single replacement reactions (redox), precipitation reactions and neutralization reactions
- write the correct formulas and names for ionic and covalent compounds, strong acids and bases
- predict the number of valence electrons and the oxidation state of elements based upon their location on the periodic table
- draw the correct Lewis structures for the formation of covalent and ionic compounds</td></tr>
</table>

expected to (F) collect data and make measurements with accuracy and precision; (G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures; (H) organize, analyze, evaluate, make inferences, and predict trends from data; and (I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports. (C.3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to (D) evaluate the impact of research on scientific thought, society, and the environment;		- explain the electron sea model of metals and how it accounts for malleability and conductivity of most metals - explain the differences between covalent, ionic and metallic bonding - predict solubility of ionic compounds using solubility rules - predict solubility of compounds using polarity and the idea that "like dissolves like" - collect data and make measurements with accuracy and precision - express and manipulate chemical quantities using scientific conventions and mathematical procedures, - organize, analyze, evaluate, make inferences, and predict trends from data - communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports.

Stage 2 – Evidence

CODE (M or T)	**Evaluative Criteria** (for rubric)	
M M T, M	-Lab Reports - Formal Test Reviews/Tests -Final project with explanation paper, gallery walk	Performance Task(s) *Students will demonstrate meaning-making and transfer by…* - Writing cogent lab conclusions - Demonstrating ability to write lab reports that are organized, repeatable, understandable, and use the appropriate scientific conventions for data recording, units, etc. - Creating an art project using chemistry and explaining the chemistry behind the processes: Each student will create their own art piece which incorporates at least 7 chemical processes. At least 4 of them must be

		concepts learned in class. The theme of the project is: "My Personal Identity." Accompanying the physical project will be a "How-To" paper which explains at least 7 of the chemical processes used to create the art piece. Also, accompanying the project will be a paper explaining the theme – how the project relates to themselves. -- Other Evidence (e.g., formative) - Practice problems - Check-ins and Exit tickets - Minute Writes - Class discussion - Pair share and small group discussion - Homework for practice problems

Stage 3 – Learning Plan

CODE (A, M, T)	Pre-Assessment *How will you check students' prior knowledge, skill levels, and potential misconceptions?* At beginning of each lab/activity, there will be a brief review and/or students will complete a Warm-Up over the review topics. This will enable the teacher to check the student's prior knowledge, skill level and any misconceptions (i.e. location of metals, non-metals on periodic table)		
M, T	**Learning Activities:** *The order of all lessons can be adjusted according to the needs and schedules of teachers and students. This unit is meant to cover approximately 9 weeks (¼ of the school year.) More or less time can be spent in the teaching of different concepts, depending on what students have already covered.* **<u>Lesson 1</u>: What is Art? And what is its connection to Chemistry?** (2 days). 1. What is Art? (powerpoint) Students will be introduced to the Essential Questions at this time, and have an opportunity to discuss their ideas with small groups. Included is a link to a ppt. showing various works of art. 2. Art Slide Show (powerpoint). 3. Artist as Chemist: Project Intro (handout) 4. Discussion of Previous Ideas and Labs the might relate to project. Discussion of what qualifies as a chemical process. Discussion of the difference between a chemical formula and a chemical equation. (The distinction between a formula and equation is included based upon the unfortunate confusion of some of my students.) 5. Overview of Artist as Chemist Unit (including lab activities). These are part of the first powerpoint. 6. Perspective of Science and Art (Show/Discuss/Read as time permits) A. Art Preservation Video. (2:46) B. ACS Video: What do Chemists do? (Conservation Science - Part 1) (3:21) ● ACS Video: What do Chemists do? (Conservation Science -		Progress Monitoring (e.g., formative data) -Pair Share Discussion -Triads/Quartets Discussion

M, A	Part 2) (1:44) • ACS Video: What do Chemists do? (Conservation Science - Part 3) (1:24) • The Art and Science of Conservation: Behind the Scenes at the Freer Gallery of Art (4:04) C. MoMA Conservation FAQs D. Art and Chemistry article E. Ted Talk: Psychedelic Science (12:04) **Lesson 2: Acid Rain** (4-5 days) *This lesson ties in chemistry and art by talking about acid rain, its effects on buildings and artwork, how it is formed, and looking at chemical equations involved in the formation of acid rain.* 1. Entry or Exit Ticket: Knowledge of Acids and Bases. Ask students to write on a paper what they know about acids, bases, pH scale, acid rain. Hand in for teacher to check or discuss in small groups and then with class 2. Pre-Lab Discussion. Have students read over procedures, data to be collected, safety concerns, and questions to be answered. Answer questions. Clarify. 3 . Lab: Simulation of Acid Rain. The purpose of this lab is to simulate acid rain and test for changes in pH. Link to Lab Students first will use Universal indicator in two samples of water, and blow into one sample with their breath using a straw. (This introduces CO_2, which then creates carbonic acid, which is shown by a color change in the Universal Indicator.) Part 2: Students will introduce small amounts for SO_2 from a pipette into a water sample that contains an indicator. The introduction of SO_2 creates sulfurous acid. *CAUTION: SO_2 is a toxic gas and should be use with caution and small quantities. SO_2 can be prepared ahead of time by carefully combining Na_2SO_3 and H_2SO_4 in a plastic Ziploc, and then extracting the SO_2 using a disposable pipette. Please use a fume hood when preparing SO_2.* 4. Debrief Acid Rain Lab. Include how Acid Rain is formed and equations. When gases such as NO, NO_2, SO_2, SO_3, CO_2 are emitted from factories or automobiles and combine with H_2O in the atmosphere, they create various acids such HNO_2, HNO_3, H_2SO_3, H_2SO_3, H_2CO_3. These then fall to the ground in the form of acid rain. 5. Direct Lecture: Acids and Bases. If students need this, go over: Strong Acids, Strong Bases, Neutralization reactions, common household acids and bases, definition of Arrhenius and Bronsted-Lowery acids and bases. 6. Direct Lecture: pH, pOH, $[H^+]$, $[OH^-]$. Definitions and calculations for these expressions. 7. Practice problems involving pH, pOH, $[H^+]$, $[OH^-]$. 8. Homework: pH problems. 9. Review/Answer Questions from homework. 10. Test Review (Handout)		-Entry Tickets (or Exit Ticket, depending upon whether this falls in a class period) -Minute Write: Explain how acid rain is formed, including at least one equation. - In-Class Practice problems - Test Review

A	11. Acid-Base Test Review: Numbered Heads Together (Divide class into groups of 4. Have them assign a number of 1-4 to each person. Show a problem or definition to work. Each group works together. When each group is done ask one of the numbers to stand. Call on one of them. If a problem is multiple parts, call on a different person from each group to answer different parts of the question). 12. Acid-Base Test Review: VoBACKulary (Before class: Create a vocabulary list for the test. Put one word on a powerpoint or sign. Divide class into 2 groups. Set up 3 chairs at front of class, leaving space behind. Teacher sits in middle chair, and assigns one person from each side to sit on either side of him/her facing the rest of the class. One student is assigned to control the powerpoint advancement. Rules: Students on each side are trying to get their teammate to say the vocabulary word on the screen first. They may not say any form of the word, give clues like "sounds like" or "rhymes with" and should be instructed/encouraged to use chemistry-related descriptions). Each student can try 3-4 words and then switch players. 13. Acid-Base Test **<u>Lesson 3</u>: Physical Behavior of Metals** (2-3 days) 1. Entry/Exit Ticket. What do students know about Alloys, Solutions, Heterogeneous and Homogeneous Mixtures? 2. Discussion/Direct Lecture/Note-taking: Alloys and examples, solutions, heterogeneous mixtures vs. homogeneous mixtures 2. Pre-Lab Discussion. Students read through lab and then ask questions. Teacher clarifies. Explanation/diagram of how a post-1982 penny goes from a heterogeneous mixture to a homogeneous mixture with gentle heating, creating the alloy: brass. 3. Lab: Physical Behavior of Metals --Part A: Penny Lab/Making Brass (in this lab, a post-1982 penny is gently heated in the cooler part of a burner flame until there is a color change. This color change is due to the mixing of the internal core of zinc with the outer layer of copper. The pre-heated penny is a heterogeneous mixture, while the penny after heating is more of a homogeneous mixture (solution, alloy). --Part B: Bobby Pin Lab/Steel: Students will heat the bend of a bobby pin and then straighten it. Students will then heat the bobby pin, let it cool on the lab table, and after it cools, test its malleability. Cooling slowly allows trapped Carbon atoms to leave, making the bobby bend more "bendy" - annealed steel. Then students will form a "J-hook" on this bobby pin, heat it again to red-hot and quickly cool it by immersing it in a beaker of cold water. This traps the carbon atoms in the structure, making it more brittle (hardened steel).. When students try to bend it, it should break. Student will then take a new bobby pin, and repeat the process, except before trying to bend the j-hook, heat gently one more time and let cool on table slowly. Then students will try to bend this 2nd bobby pin. It should be less		-Numbered Heads Together - Review Game -Entry Tickets (or Exit Ticket, depending upon whether this falls in a class period)

A	malleability than the first slowly-cooled bobby pin, but less brittle than the J-hook bobby pin that was quickly cooled. This is because this type of "tempered" steel has a medium amount of carbon present. 4. Lab Debrief 5. Lab Write-up Due **<u>Lesson 4</u>: Chemical Behavior of Metals** (3-4 days) 1. Pre-Knowledge Check: Metals, non-metals, polyatomic ions, symbols and names of common elements. 2. Introduce Reactivity of Metals/Single Replacement Reactions/Activity Series of Metals 3. Demonstration of $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$ and $Zn(s) + CaCl_2(aq) \rightarrow$ No Reaction *(Note: these are examples of single replacement reactions and in the first one, the zinc should start to dissolve (losing electrons and going into solution), while copper gains electrons and precipitates out. In the 2nd reaction, nothing should happen because Zn is less reactive than calcium.)* 4. Examples and Practice problems using Activity Series of Metals (incl. Hydrogen) and Halogens 5. Homework: Activity Series problems/Predicting the Correct Products. 6. Pre-Lab: Chemical Behavior of Metals 7. Lab: Chemical Behavior of Metals -Part A: Comparing Activity of Metals using voltage (Metal strips of Cu, Al, Mg, Sn, Zn, Fe, Pb are attached to a 9-Volt battery, a voltmeter, and then placed in a salt water solution, 2 at a time. Reactivity is compared based upon negative or positive readings, and the reactivity of the metals is determined based upon experimental results, which is then compared to the established reactivity.) -Part B: Comparing Activity of Metals with Hydrogen (using Hydrochloric Acid) (Small pieces of each metal are dropped into HCl(aq) to determine their reactivity compared to Hydrogen. These experimental results are then compared to the established results.) -Part C: Electroplating a Nickel using Copper Sulfate Solution (A nickel is attached to a 9-volt battery and an alligator clip and dipped into a copper (II) sulfate solution in order to coat the nickel with a copper veneer.) Electroplating is a process that can be used in creating works of art. 8. Debrief each portion of lab. 9. Exit Ticket 10. Pre-Knowledge Check: Definition and how to find: Valence Electrons 11. Lesson: Determining valence electrons and assigning charges/oxidation states. 12. Rules for assigning oxidation states to elements in a compound or polyatomic ion		-- Lab Write-up and Conclusion - Pre-Assessment or Entry Ticket - In-Class Practice Problems - Homework: Practice Problems -Exit ticket: knowledge of activity series -Entry ticket: valence electrons

	13. Practice assigning 14. Introduction to Redox (reduction/oxidation) reactions. 15. Memorization techniques: 1) LEO the lion says GER (Losing Electrons Oxidation and Gaining Electrons Reduction 2) OIL RIG - Oxidation Is Loss and Reduction Is Gain. 16. Practice Problems for determining which elements are reduced and which are oxidized in a chemical reaction. 17. Homework: Redox 18. Homework check.		-In class practice problems -Homework: practice problems
A, M, T	**<u>Lesson 5</u>: Precipitation Reactions, Solubility Rules and Paints** (3-4 days) 1. Demo: $KI(aq) + Pb(NO_3)_2(aq) \rightarrow KNO_3(aq) + PbI_2(ppt)$ This demo starts with two aqueous solutions which are added together producing a bright yellow solid or precipitate. 2. Online Animation/Illustration (Find an online animation or draw for students showing the four ions in solution before Pb^{2+} and I^- are attracted to each other and precipitate out of the solution.) 3. Solubility Rules Chart: Show students how to read and determine whether a given compound is soluble or insoluble. 4. Practice Problems: Predicting products in a precipitation (double displacement) reaction. 5. Pre-Lab 6. Lab: Part A: Precipitation Reactions (multiple aqueous ionic solutions are combined to see which ones produce solids.) 7. Lab: Part B: Making Paints. Students will use insoluble compounds and a binder (such as linseed oil, water, and guar gum) to make paints and then test them for their color when dry.		-In-class practice problems -Lab write-up and conclusion
A, M, T	**<u>Lesson 6</u>: Synthesis of Prussian Blue** (2-3 Days) *In this lesson, students will create the first known pigment, Prussian Blue, using a precipitation reaction. They can use their product in their project, if they wish.* 1. Pre-Lab Discussion 2. Lab: Synthesis of Prussian Blue. 3. Lab Debrief 4. Revisit the Project: How can Prussian Blue be used? What other project ideas do you have?		
A	**<u>Lesson 7</u>: Bonding** (4-5 days) 1. Review of Ionic, Covalent, and Metallic Bonding 2. Lewis Dot Structures: Note-taking 3. Formation of Ionic Compounds and Covalent Bonding (drawing dot structures to explain formulas and arrangement of atoms) 4. Test Review 5. Practice Problems		- Entry ticket (knowledge of ionic, covalent and metallic bonding, compounds) -In class practice problems

M, T	6. Test 2: Reaction Types, Bonding, Properties of Metals **<u>Lesson 8</u>: Clay and Hydrates** *(Optional)* (3 days) This lab could be optional or omitted as time permits. Teacher or student could still purchase/use air-drying clay and have students investigate the chemical make-up of hydrates and how clay works. 1. Pre-Lab Discussion. Plan for experiment. 2. Lab: Part A -- observe clay crystals with hand lens, investigate, discuss results 3. Lab: Part B -- Investigate the amount of water in a hydrate of unknown formula. 4. Post-Lab Discussion 5. Discussion about project		-Test Review
A, M, T	**<u>Lesson 9</u>: Solvents and Solubility** (4 days) 1. Pre-Lab Discussion. Check for pre-knowledge: what affects solubility (2 factors to consider: how much will dissolve and how quickly it will dissolve) 2. Lecture and Notes: Polarity: Polar vs. Non-polar molecules 3. Lab: Part A: Solvents and Solubility. Students will be testing the solubility of different solids (NaCl, KI, NaI, I_2) in various liquids (water, ethanol, vegetable oil, glycerol) 4. Lab: Part B: Marbleized Paper (This lab uses food coloring, shaving cream, and paper to create colored designs on paper. Shaving cream is added to a paper plate or even a table top. Drops of food coloring are added the shaving cream and then slightly stirred to create patterns. A piece of paper (or canvas) is pressed against the shaving cream/food coloring mixture and then removed. The shaving cream (both polar and non-polar) is carefully and gently scraped off using a ruler or straight edge. The food coloring (polar) is left on the paper (polar). 5. Post-Lab Discussion		- Entry ticket: factors affecting solubility Lab write-up and conclusion
M, T	**<u>Lesson 10:</u> Dyes** (3 days) *Students will determine a procedure for extracting dyes from natural materials and use them to dye cloth (wool, cotton, linen, silk). Students will then examine factors that affect the colorfastness of dyes.* 1. Pre-Lab Discussion 2. Lab: Part A: Making Natural Dyes 3. Lab: Part B: Testing Colorfastness (students will test colorfastness of natural dyes by treating cloth or yarn with a mordant, or metal salt, and then dying the material with one of the natural dyes) 4. Post-Lab Discussion **<u>Lesson 11</u>: Glazes and Glass** (2 days) *In this lab, students will discover what gives glazes and glass their*		

M, T M, T	*color and examine the effect of heat on the colors of glass and glazes.* 1. Pre-Lab Discussion 2. Lab: Creating and coloring glass beads using borax and metal oxides. Students will start with nichrome wire or glass stirring rods. Students will create glass beads using borax (sodium borate $Na_2B_4O_7$), which is heated over a burner flame at the end of the a glass stirring rod or loop of nichrome wire. Once a glass bead is created, students will dip the bead (still attached to the wire or glass rod) in on of several metal oxides and heat again, creating glass bead of varying colors. 3. Post-Lab Discussion **Lesson 12: Presentations!** If possible students might have time in class to work on projects, utilizing art materials and available lab materials from labs included in this unit. When the projects are due, students should set them up around the room with the placards. Students can do a gallery walk to see the projects. Each student will also present his project to his or her chemistry class, explaining the theme, explaining how it was made, and explaining at least one chemical process. Teacher assesses applicable parts of the rubric during presentations.		