Phoenixville Area School District Understanding by Design (UbD) Science Template

Grade Level &/or HS Subject: 11/Chemistry Unit Name: Electrochemistry

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="3">Overarching NGSS & PA Standards:

PA: <u>Properties and Structure of Matter:</u>
1.Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
2.Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
<u>Chemical reactions:</u></td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

• Ask questions and/or define problems
• Plan and/or carry out investigations
• Analyze and interpret data using computational thinking
• Obtain, evaluate and communicate information (supported by evidence)
• Construct explanations and design solutions</td></tr>
<tr><td colspan="2">Meaning-Making</td></tr>
<tr><td>Students will understand that…
• PS1.A: Structure and Properties of Matter: The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (Secondary to HS-PS2-6)
• PS2.B: Types of Interactions: Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HS-PS1-1), (secondary to HS-PS1-3)
• SEP: Obtaining, Evaluating and Communicating Information: Scientific and technical information (e.g., about the process of development and the design and performance of a proposed process or system) in multiple formats can be communicated (including orally, graphically, textually, and mathematically). (HS-PS2-6)
• PS1.B: Chemical Reactions: The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2), (HS-PS1-7)
• Batteries are electrochemical cells, and batteries of different types are currently being used to replace other outdated forms of energy that are less reliable, less available, more damaging to the environment and becoming increasingly more expensive as human demand increases.</td><td>ESSENTIAL QUESTIONS
Students will keep considering…

• How do models that we create in lab of electrochemical cells relate to the real world?
• What are the advantages and disadvantages to these models we create in lab?
• Why is it important to collect data about the performance of a proposed tool, object, process or system under a range of conditions?
• What are the benefits of communicating scientific information in multiple ways?
• How does science change over time?</td></tr>
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1. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. 5. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. HS-PS1-1.Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-3.Plan and conduct an investigation to		• How does one characterize and explain redox reactions and make predictions about them? • How do humans depend on Earth's resources? (ESS.3A)
	Knowledge and Skills Acquisition	
	UNDERSTANDINGS *Students will know…* • *The activity series is a table used to identify elements that are more or less easily oxidized, and it can be related to standard reduction potentials.* • *That voltaic cells spontaneously produce energy, and electrolytic cells use energy to function.* • *Voltaic cells can be properly labeled to show understanding of how closed circuits function.* • *The standard hydrogen electrode is used for comparison of all other half-reactions.* • *The standard cell potential can be calculated from standard reduction potentials of the cathode and the anode, and its sign signifies the spontaneity of that redox reaction.* • *Electrolysis is a chemical process whereby electricity is a source of breaking intramolecular bonds in order to obtain elements of the compounds they make up and is useful in electroplating and other types of metal processing in real life.*	*Students will be skilled at…* SEP. Developing and Using Models: Developing a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4), (HS-PS1-8) SEP. Developing and Using Models: Using a model to predict the relationships between systems or between components of a system. (HS-PS1-1) SEP. Using Mathematics and Computational Thinking. Using mathematical representations of phenomena to support claims. (HS-PS1-7) SEP. Constructing Explanations and Designing Solutions. Applying scientific principles and evidence to provide an explanation of phenomena and solve design problems, considering possible unanticipated effects. (HS-PS1-5) SEP. Constructing Explanations and Designing Solutions. Refining a solution to a complex real-world
	KEY VOCABULARY Electrochemical cell, salt bridge, anode/cathode Electrode, activity series, dry cell Fuel cell, battery, standard reduction potential Standard cell potential, electrolytic cell, voltaic cell Electrolysis, electroplating, standard hydrogen electrode	

gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS1-7.Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. HS-PS2-6.Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **Which branch(es) of science apply:** **LS PS E&SS**		problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6) SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7) MP.4 Model with mathematics. (HS-PS1-4), (HS-PS1-8)

Stage 2 – Evidence		
Evaluative Criteria	***Assessment Evidence***	
Lab rubric performance points Formative checks of understanding Presentation rubric	PERFORMANCE TASK(S): • *Students will create a lemon battery, answer some questions about its functioning, and label the parts akin to a voltaic cell.* • *Student demonstration: redox reaction of silver "tree" using silver nitrate and copper wire, followed by discussion of activity series and relating it to half-cell potentials.* • *Students can simulate a lead storage battery (like in cars) by making a lead cell, that they connect to a 6-V DC source that will ring a doorbell.* • *Students will orally present in groups about the emerging trend of electric cars and discuss what obstacles still stand in the way of mass usage of these cars, or students can choose to discuss the use of fuel cells for space travel in the space shuttle and used by utility companies. In all cases, a comparison to other fuel sources should be made in terms of their impact on the environment.*	Differentiation Considerations: Group considerations, roles in group, variable performance tasks within labs Prior to labeling, choose some students who may do better with visual learning: Give students small, printed cards with *e-* printed on them in large letters. Divide students into pairs and let one student role play being the anode and the other being the cathode. The anode should have one or more cards to the anode, depending on the metal chosen. Enrichment: Challenge students to research the electrochemistry of the body's nervous system and have them report their findings in a visual display. Some topics could be the role of sodium and potassium ions, how signals are transmitted across synapses, what an EEG measures and the value of squid for nervous system research.

Performance point values Lab report rubric Teacher formative checks	OTHER EVIDENCE: Cooperative Learning Drills: identifying oxidation numbers, predicting direction of reaction (voltaic or electrolytic cells) based on standard reduction potentials Formative Assessments and Homework: oxidation numbers, balancing half reactions, balancing redox reactions, labeling voltaic cells, calculating cell potentials Laboratory Experiments: creating electrochemical cells Common Summative test: Electrochemistry	Differentiation Considerations: English learners: Review the content looking for vocabulary words and key concepts. Add drawings to these words for meaning and try to use them in various types of sentences. English learners or less proficient readers: Students may have difficulty remembering that oxidation occurs at the anode and that reduction occurs at the cathode. Tell them that the consonants go together and vowels Spiral some of the learning in this unit to help students remember the patterns in chemistry: Have students look at the periodic table and point out that the elements on the left side of the periodic table are more easily oxidized (lose e^-) than the elements on the right side of the periodic table. Groups 1 and 2 are the most reactive metals and are at the top of the activity series (when we studied chemical reactions). Au, Ag and Cu represent some of the most stable elements in nature. They are not readily oxidized and will act as the cathode (they get reduced).