**UNIT PLAN OVERVIEW: ELECTROCHEMISTRY**

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| **Group members:**   1. Farah Farah 2. Shirley Easo   **Unit: 5** *Electrochemistry Grade 12(U)*  ***General Expectations***  By the end of this unit students will,  F1. Analyze technologies and processes relating to electrochemistry, and their implications for society, health and safety, and the environment;  F2. Investigate oxidation-reduction reactions using a galvanic cell, and analyze electrochemical reactions in qualitative and quantitative terms;  F3. Demonstrate an understanding of the principles of oxidation-reduction reactions and the many practical applications of electrochemistry. |
| 1. **ENDURING UNDERSTANDINGS AND KEY SKILLS**   (Critical thinking skills & connecting it to the real world) |
| **KEY CONCERNS(** Relating Science and Technology to Society and the Environment)  **Why is this topic important to us?**  We literally cannot live without electrochemistry because even for the proper cell functioning and transmission of signals through the nervous system we need electrochemical reactions. There are numerous and vital electrochemical processes in both nature and industry.  Electrochemistry is extremely important in a wide range of technological applications, such as batteries for mobile devices and vehicles, the electroplating of objects with metals or metal oxides and the detection of alcohol in drunken drivers through the redox reaction of ethanol. The generation of chemical energy through [photosynthesis](http://en.wikipedia.org/wiki/Photosynthesis) is actually an electrochemical process, as is production of metals like aluminum and titanium from their ores. Certain diabetes blood sugar meters measure the amount of glucose in the blood through its redox potential.  **What should we do about it?**   * **assess, on the basis of research, the viability of using electrochemical technologies as alternative sources of energy (e.g., fuel cells for emergency power generation or as power sources in remote locations), and explain their potential impact on society and the environment** * **analyze health and safety issues involving electrochemistry (e.g., corrosion of metal pipes in drinking water systems)** |
| **KEY SKILLS:** ( Developing Investigation and Communication Skills)  (F2. investigate oxidation-reduction reactions using a galvanic cell, and analyse electrochemical  reactions in qualitative and quantitative terms)  **What should students be able to do/learn to do?**  *Students should be able to*   * use appropriate terminology related to Electrochemistry like   *half-reaction, electrochemical cell, reducing agent, oxidizing agent, redox reaction,* and *oxidation number*   * write balanced chemical equations for oxidation-reduction reactions, using various   methods including oxidation numbers of atoms and the half-reaction method of balancing   * build and analyze processes in galvanic cell |
| **When students have finished the unit, what “big ideas” will remain with them?** (These may be similar to the basic concepts, or to the “Big ideas” listed in the unit; but they may be fewer in number or modified to fit the interests of the teacher or students.)   * Energy can be transferred from one form to another .Electrochemistry is the branch of chemistry which deals with the transformation of electrical energy into Chemical energy and vice-versa. * Knowledge of electrochemistry is of immense importance to study about the causes of destruction of materials caused due to corrosion. * Oxidation and reduction are paired chemical reactions in which electrons are transferred from one substance to another in a predictable way. * The control and applications of oxidation and reduction reactions have significant implications for industry, health and safety, and the environment.   . |
| ***ESSENTIAL QUESTIONS TO FOCUS AND GUIDE THE UNIT:***   1. How is chemical energy converted to electrical energy and vice versa? 2. What is the difference between galvanic cells & electrolytic cells? 3. What happens to batteries disposed of in a landfill? How should they be disposed? 4. What impact has the use of rechargeable batteries in portable electronic devices had on society? 5. Why do metal orthodontic braces not corrode? 6. What are some of the toxic substances that can escape from electronic waste into the environment? What are the potential effects of these poisons on our health? 7. Analyze the health and safety issues associated with the corrosion of metal pipes and drinking water systems. 8. Why is rusting referred to as an electrochemical process? What is the financial cost to society of rusting? How can rusting be prevented? What are some of the techniques used to protect metals from corrosion? 9. What are the benefits and risks to the environment of the electroplating of metals? What health and safety hazards are associated with waste generated by electroplating companies? |

**Sequence of lessons** :75minutes each

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| 1. Intro to oxidation and reduction reactions  2. Redox Reactions (Half reactions & balancing equations  3. Redox Reactions  4. Redox reactions & Oxidation Numbers  5. Applying Oxidation Numbers to Redox Reactions  6. Writing balanced redox equations using Half- Reaction Method  7. Corrosion & its impact on society  8. Galvanic Cells  9. Measuring Cell Potential  10. Measuring Cell Potential : Hands on | 11. Standard Potential  12. Electrolysis & Electrolytic Cells  13. Factors that determine selective discharge of ions  14. Understanding Faraday’s Law  15. Faraday’s Law & electroplating  16. Case Study  17. Unit Test/portfolio/project  18. Culminating Activity (Class time)   1. Culminating Activity (Presentations) 2. Culminating Activity (Presentations) |

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| **Lesson** | **Specific expectation** | **Lesson Strategy and Assessment** | **Evaluation including criteria addressed from Achievement Chart** |
| **5.1**  **Processes related to electrochemistry: Redox Reactions** | | | |
| 1. Introducing oxidation and reduction reactions   *By the end of the lesson students will:*  - know the definition of oxidation and reduction  - see a redox reaction and investigate the chemical equations  - connect how redox reactions affect their daily lives | F2.1  F2.2 | **Minds on** : *Watching a* ***U tube clip* :** Introduction to redox reactions <http://www.youtube.com/watch?v=ICMfgSBNQzs> (30 minutes)  Students will learn about real life occurrences of oxidation-reduction reactions. They will learn how these redox reactions are behind many known phenomena, from paper becoming yellow to apples becoming brown to fire to the most destructive of explosions. They will also learn about the origin of the words oxidation & reduction  Inquiry & discussion  Ask essential questions about the clip to help students to understand redox equations (15min)  Think Pair Share: Students brainstorming with elbow partner other everyday redox reactions (i.e., corrosion) and share with class. **Teacher Evaluation** – use as a Diagnostic Test, takes anecdotal notes (10min)  Journal entry : students write a short report in their electrochemistry journal  (20min)  **Diagnostic test :** Tiered multiple choice questions | Knowledge & Understanding  Thinking  Communicating |
| 1. Redox Reactions   (Half reactions & balancing equations)  *By the end of the lesson students will:*  - be introduced to and visualize (computer simulation) reactions in a redox equation  - practice predicting the oxidation of metals | F2.1  F2.3  F3.1 | Minds on : “Animal electricity”  *Back in the late 1700’s, Luigi Galvani observed that electrochemical behavior of two dissimilar metals (Zn and copper )in a bimetallic arch, in contact with the electrolytes of tissue, produces an electric stimulating current that elicits muscular contraction.* **(u tube clip)** 5min  Demonstration + Internet animation: Zinc /copper redox reaction  [**http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/CuZncell.html**](http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/CuZncell.html)  Direct instruction + discussion: Redox -Half reactions and balancing equations (20min)  **Introducing mnemonics :**  **“LEO the lion says GER”**  **LEO: Loss of Electrons is Oxidation**  **GER : Gain of Electrons is Reduction**  Computer Simulation: Single Replacement Simulations <http://www.infoplease.com/chemistry/simlab/>  Cooperative Problem Solving: using the activity series, student groups predict the oxidation of metals (35min)  Culminating Activity - culminating activity is introduced & groups and sign up (15min) | K/U  T/I |
| 1. Redox Reactions   (Introducing activity series)  *By the end of the lesson students will:*  - use the activity series of metals to predict reactions  - practise their presentation skills | F2.1  F2.3 | **Demonstration : reaction of solid copper with silver nitrate solution**  This is a very simple demonstration and within a few minutes the solid copper begins to darken, then turn "fuzzy" as the silver comes out of solution to form a solid. The solution will begin to turn blue as Cu2+ ions enter the solution.  This demonstration could be paired with the Zinc - Copper redox reaction to introduce the activity series.  Discussion & brain storming **:**  **(open ended questioning method)**  -redox reactions taking place during the demonstration.  -where to place copper and silver in the series  - balanced half reactions for the chemical reactions taking place  Cooperative Problem Solving: In small groups, students practice the balancing of half reactions and predict reactions based on the activity series of metals  (McGraw Hill pgs. 467-468, 470-479) (30min)  Cooperative Presentations: Each group will present one question on balancing half reactions and will show step by step how they arrived to that answer. Each person in the group needs to speak. The rest of the class confirms whether or it is correct. (formative assessment)  (40min) | K/U  T/I  A  C |
| 4. Redox reactions & Oxidation Numbers  *By the end of the lesson students will:*  - be aware of the oxidation number rules and how to use it | F2.1  F2.3 | **Minds on (Simulation)**  <http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/redox/home.html> (5 minutes)  JIGSAW: Using jigsaw as a strategy, students learn the Oxidation Number Rules (25min)  Think, Pair, Share: Individually, students find the oxidation numbers of elements, showing each step they made to arrive to the answer. In pairs, they assess each other’s answers and then share it to the class – **Self, Peer and Teacher Evaluation** (anecdotal notes)(25min)  Class Discussion: Teacher takes up correct answers with entire class (15min) | K/U  T/I  C |
| 5. Applying Oxidation Numbers to Redox Reactions  *By the end of the lesson students will:*  - practice balancing redox reactions using oxidation numbers  - have a chance to practice their presentation skills | F2.1  F2.3  F3.1 | Direct instruction + power point presentation: Teacher explains how to apply oxidation numbers to redox reactions (15min)  Small Group-Problem Solving:  Tiered worksheet (20min)  Student Presentations: Groups present their solution/explanation to one of the questions to the class. Teacher provides groups with presentation feedback – **Teacher Evaluation** – formative rating scale (40min) | K/U  T/I  C  A |
| 6. Writing balanced redox equations using Half- Reaction Method  *By the end of the lesson students will:*  - practice writing balanced redox equations using the Half-Reaction Method | F2.1  F2.3 | Lab Demo: In this demonstration, which could be done as a student lab, zinc and iodine are reacted to produce zinc iodide. This reaction is an oxidation-reduction reaction. It is useful to combine this lab/demonstration with the decomposition of Zinc Iodide demonstration. (20min)  Inquiry method: Ask student questions referring back to the lab to explain using half reactions to balance equations (15min)  Cooperative Problem Solving: In small groups students balance redox reactions using the Half-Reaction Method. **Teacher Evaluation** – while students work, takes anecdotal about their work habits, understanding (30min)  **Home assignment : Directions:**  1. Start Internet Explorer or Netscape and go to  www.dorjegurung.com/chemistry/IB\_year1/balancing\_equation\_games/index.htm.  2. Click ‘Directions’. Read and understand the directions.  3. Click ‘OK’.  4. Click on ‘Redox reactions in acidic and basic mediums.’  5. Try entering some numbers in the text boxes in front of each molecule. What happens?  6. If you forget the directions, click on the ‘How to Play the Game’ link. Click ‘OK’ when you  finish reading them to return to the game.  7. When you think you have typed the right numbers in all the boxes, click the ‘Balanced’ button.  8. If you didn’t get it right, try again.  9. If you did get it right, then fill in the correct answers on this worksheet for #1.  10. Repeat steps 7-9 for the rest of the questions that appear in the game. |  |
| 7.  Corrosion  Culminating Activity Discussion  *By the end of the lesson students will be able to understand & appreciate :*  - corrosion and effects of corrosion on society & environment | F 1.2  F 2.2  F3.5  F 3.6 | **Corrosion Investigation & Presentation**  **Eight** **learning stations** are organized  **S**tudents investigate and summarize factors affecting corrosion and corrosion prevention.  Station #1: Steel Wool (moist) Corrosion  Station #2: Steel Wool + bleach Corrosion  Station3 : Steel wool + vinegar corrosion  Station #4: Iron Nail Corrosion  Station #5: Corrosion Prevention: Copper Plating of an Iron Nail  Station #6: Aluminum Foil Corrosion  Station #7: Aluminum Foil Corrosion  Station #8: Corrosion of Pure Iron / Galvanized Iron Nails  Differentiated Assessment: Students are asked to go to stations and report the results & observations in whichever way they would like to express themselves (ie. written, lyrical drama, hand-on, visual etc.). In groups, students will present a concept that has been taught so far in their preferred learning style. **Peer + Teacher Evaluation** (formative rating scale) (30min)  Culminating Activity (CA) planning: Students are given some time to start planning their CA.  Home assignment : Differentiated (Journal/logbook/wiki)  Students choose any one of the following sites to go to and reflect on corrosion & its impact on society & environment   1. Corrosion Doctor’s Website:   <http://corrosion-doctors.org/index.htm>   1. Electrochemical Corrosion Protection:   <http://corrosion-doctors.org/Corrosion-History/Electrochemical.htm>   1. Corrosion in History:   <http://corrosion-doctors.org/Corrosion-History/Introduction.htm>   1. Historical Theories on Corrosion:   <http://corrosion-doctors.org/Corrosion-History/Theories.htm>   |  | | --- | | Corrosion Story: **A Costly Lesson About Corrosion** *by Mike Busch* | |  |   <http://www.cessnapilotsassociationofaustralia.org.au/tech1article.html> |  |
| **5.2**  **Investigate & analyse electrochemical reactions: Cells and Batteries** | | | |
| 8. Galvanic Cells  *By the end of lesson, students will be able to:*  -understand galvanic cells  - Identify components of and explain how galvanic cell works  - Be aware of the need to recycle modern rechargeable batteries, such as those in computers and cellular telephones, because of the poisonous  heavy metals they contain (e.g. mercury and cadmium) | F 2.1  F 3.2  F 1.1 | -Teacher presentation +Demo / Video:  Shows the reaction at each electrode for a Cu/Zn cell.  http://www.chembio.uoguelph.ca/educmat/chm19105/galvanic/galvanic1.htm  (20min)  Lab: Students work in groups to create a lemon battery (35min)  **Quiet reading time ☺** (20 min)  Students will be provided a choice of articles or books on batteries and safe disposal. The students are asked to critically analyse the article and write a report in their journal.  The article will help them to appreciate the :  - need to be aware of the environmental effects of disposing batteries  - need to recycle rechargeable batteries  **Homework**  Surf the following website which has a virtual chemistry laboratory that allows you to set up and test a variety of galvanic cells and take “data”. <http://web.mst.edu/~gbert/Electro/Electrochem.html>  The students share their work using wiki  **Teacher Formative/ Diagnostic Evaluation** -Review student posts. Determine understanding of applications | K & U  A  I |
| 9. Measuring Cell Potential  *By the end of lesson students will be able to:*  -Define: electric potential; cell voltage; cell potential | F 2.1  F 2.6  F 3.3 | **Minds on ; u tube clip : measuring potential**   1. http://www.youtube.com/watch?v=WU5zY9RgKzM&feature=related 2. http://www.youtube.com/watch?v=cqCZ2B4fsBg   Direct instruction :+ Power Point Presentation on cell potential  (40min)  Quiet time (reading) ☺: Read and prepare for Lab ‘Measuring Cell Potentials of Galvanic Cells’ (35min) | K & U  T |
| 10. Measuring Cell Potential: Hands on  *By the end of lesson students will be able to:*  -Identify factors affecting cell potential of GC  -Write balanced half reactions for their cells | F 2.4  F 2.5  F 3.2  F 2.2  F 2.3  F 3.1 | Pre-Lab Demonstration: (10min)  Students perform lab: Measuring Cell Potentials of Galvanic Cells (65min)  Students submit lab results  **Teacher Formative Evaluation** -Assess student understanding of half cell reaction and cell potential | K & U  T  C |
| 11. Standard Cell Potential  *By the end of lesson students will be able to:*  -Use the ‘Standard Half-Cell Potentials’ table  -Calculate standard cell potentials  - predict the spontaneity of redox reactions, based on overall cell potential | F 2.1  F 2.6  F 3.4  F 2.3 | PowerPoint presentation : http://www.sciencegeek.net/Chemistry/Powerpoint/Electrochemistry/Electrochemistry\_files/frame.htm  Direct instruction & Guided practice(solving problems) on standard cell potential (20min)  Cooperative Problem Solving:  Quiet reading : related article/textbook  Practice Problems (Independent practice, students work in small groups & present one solution  (55min)  Homework: Tiered practice problems | K & U  T |
| 12. Electrolysis & Electrolytic Cells  *By the end of lesson students will be able to*:  -Explain difference between Electrolytic cells and Galvanic Cells  -Difference between electrolytes & non electrolytes  -Analyse the electrolysis of molten compounds & aqueous solutions | F 2.1  F 2.6  F 3.1 | Presentation +animation + lecture +open ended questions  (25min)  **-Investigate the electrolysis of molten lead (II)bromide**  **-Investigate the electrolysis of aqueous copper(II) sulphate & identifying the cations & anions present in the solution**  Students compare & contrast electrolysis of aqueous & molten electrolytes. Concept Attainment Strategy Maps in groups of 3 – 4. **Peer Evaluation** – verbal feedback (40min)  Homework: Concept Attainment Strategy Map on difference between electrolytic & galvanic Cells | K & U,  T  C |
| 13. Factors that determine selective discharge of ions  *By end of lesson students will be able to:*  -Predict the product of electrolysis | F 2.1  F 2.6  F 3.1 | **Presentation + animation + simulation + Direct instruction**  Predicting the product formed at the electrodes :  Electrolysis of aqueous copper (II) sulphate using   1. **Carbon electrodes (inert)** 2. **Copper electrodes**   Factors that determine the selective  discharge of ions at the electrodes.  -position of ions  -concentration of ions  -types of electrodes  (30min)  Students share concept attainment through **mind maps/Venn diagram** in small groups.  **Peer Evaluation** – verbal feedback (30min)  Whole Class Interactive Learning: Complete ‘Predicting Products of Electrolysis of aqueous solutions’ Sample Problem on pg 529 -531  -in class work on sample problem on pg 529 (15min)  Homework : Problems on pg 531 & pg 534 – 535 (calculations); Practice Problems Q 13 -16 on pg 531 | K & U,  T  C |
| 14. Understanding Faraday’s Law  *By end of lesson students will be able to:*  -Calculate the relationship b/w the amount of electrons and the amount of an electrolysis product | F 2.1  F 2.3 | Mind on : u tube clip  <http://www.youtube.com/watch?v=qnU7HQ18cGA&feature=related>  <http://www.youtube.com/watch?v=oKrJhofpFpk>  **Gold plating a mobile phone**  Lecture + Guided inquiry:  Faraday’s law +  Sample Problems (20min)  In-class work:  Independent practice /work in groups  Complete Practice Problems (25min)  Exit slip (15min)  Applications of electrochemistry  CA Checklist: A checklist is used to makes sure students are progressing along with CA.  **Teacher Evaluation,** formative checklist (15min) | K & U, T |
| 15. Faraday’s Law & Electroplating (application)  *By the end of lesson students will be able to:*  - Describe electroplating  - justify how plating is governed by **Faraday's Laws**  ־ Draw labeled diagram to show electroplating of an object  -Analyse benefits and harmful effects of electrolysis in Industries. | F 2.2  F 2.3  F3.5  F3.6 | Two Stay and One Stray (Co-op Learning Strategy): before lab, one of three goes to another group to verify hypotheses about lab. **Peer Evaluation** (informal) (15min)  Electroplating a spoon (lab): (60 min)  Electroplating an iron spoon with silver using a dilute solution of silver nitrate  **Extension activity :**  **Activities on electroplating**  <http://www.yenka.com/activities/Electroplating_-_Activity/>  Go to the above web site ,complete the activities and enter reflections in your journal | K & U  T  C / I |
| **5.3 Applications/Integration of the understanding of Electrochemistry to daily life** | | | |
| 16. Review –case study or other differentiated activity  *By the end of lesson students will be able to:*  **-** incorporate the concepts and skills learned so far to solve a case study in a cooperative learning environment | F 1.2  F 2.1  F 2.5  F 3.1  F 3.5  F 3.6 | ­Quiz: Formative assessment of student learning so far. **Self + Teacher Evaluation** (15min)  Case Study: student engagement ,participation ,enthusiasm and safety awareness are assessed.(60min)  **Peer & teacher Evaluation** | K/U  T/I  C  A |
| 1. 17. Unit Test/Project based work/portfolio/ 2. logbook (optional) | F 2.1  F 2.3  F 2.6 | Differentiated & modified test  Multiple choice/short answer/essay/other tiered questions  (75min) | K & U, T, C, A |
| 18. Culminating Activity (class time) | F 1.2  F 2.2  F3.5  F 3.6 | The computer lab /library to be used by students to work on their CA (75min)  **Peer Evaluation**  - checklist  **Teacher Evaluation**  - anecdotal notes, checklist | C  A |
| 19. Culminating activity (Presentations) | F 1.2  F 2.2  F3.5  F 3.6 | **Peer Evaluation**  - rating scale  **Teacher Evaluation**  - rubric  (75min) | K  T  C  A |
| 20. Culminating activity Presentations | F 1.2, F 2.2, F3.5, F 3.6 | **Peer Evaluation**  - rating scale  **Teacher Evaluation**  - rubric (75min) | C  A |

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| **D) RESOURCES, EQUIPMENT, MATERIALS, SAFETY** |
| 1. The Ontario Curriculum, Grades 11 and 12: Science, 2008 (revised)   <http://www.edu.gov.on.ca/eng/curriculum/secondary/2009science11_12.pdf>   1. www.saskschools.ca/curr\_content/chem30\_05/6\_redox/teacher/redox\_teacher\_labs.htm#synthesis 2. Mustoe, Frank (2002). Chemistry 12. Toronto: McGraw-Hill Ryerson 3. Success Chemistry (Oxford Fajar) 4. Wistrom, Cheryl; Phillips, John; Strozak, Victor (1997). Chemistry: Concepts and Applications. Ohio: Glencoe / McGraw-Hill. 5. pplazekgrade11physics.wikispaces.com/.../SCH4U+-+**Electrochemistr**y 6. Copper/Zinc Electrochemical Cell: Awesome animation with commentary; the molecular level is emphasized and very detailed, including details about the molecular movement in the salt bridge.   [**http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/galvan5.swf**](http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/galvan5.swf)   1. Voltaic Cell Simulation: Includes molecular level reactions, E values to calculate electrode potential, shows electron flow, and the metals Ag, Cu, Zn and their corresponding solutions (with choice of concentration) are included.   (Scroll down to Electrochemical Cells until you reach the Voltaic Cell.)  [**http://www.chem.fsu.edu/chemlab/chm1046lmanual/electrochem/background.html**](http://www.chem.fsu.edu/chemlab/chm1046lmanual/electrochem/background.html)   1. Voltaic Cell Simulation: A similar simulation to the one above but with hydrogen as well as Ag, Cu and Zn.   [**http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/electroChem/voltaicCell20.html**](http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/electroChem/voltaicCell20.html)   1. Tom Greenbowe Animation: Shows a copper/zinc electrochemical cell with detailed molecular view of each compartment.   [**http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/CuZncell.html**](http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/CuZncell.html)   1. Another animation: Shows the molecular components at each electrode for a Cu/Zn cell.   [**http://www.chembio.uoguelph.ca/educmat/chm19105/galvanic/galvanic1.htm**](http://www.chembio.uoguelph.ca/educmat/chm19105/galvanic/galvanic1.htm)   1. Zn/Cu transfer: This animation shows the molecular level reaction of zinc metal in a solution of copper(II)nitrate.   [**http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/ZnCutransfer.html**](http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animations/ZnCutransfer.html)   1. The following website has a virtual chemistry laboratory that allows you to set up and test a variety of galvanic cells and take “data”. It even varies the data for each user, and normally does not give “perfect” results, but data that would be expected from a lab that is set up with care using the proper materials and equipment. 2. <http://web.mst.edu/~gbert/Electro/Electrochem.html>   http://en.wikipedia.org/wiki/Electrochemistry  **Resources** *Various lesson plans and ideas from Ontario curriculum ,student texts, and from the web.*  **Safety** *“Be safe!” Teacher will review with students at the beginning of the unit (year).* |
| **E) DIFFERENTIATED LEARNING, ACCOMMODATION, INTEGRATION**  *Resource: ”Start where they are” Karen Hume (1, 2, 3)*   1. *Pre-assess students one - two weeks before the beginning of the unit.* 2. *Teacher should use the observations from the hands-on activities as a form of individual pre-assessment. Teacher should regrouped students for the next activities based on these results to make students engage with the essential concepts of the unit.* 3. *Teacher should discuss the intended learning outcomes with the students at the beginning of the unit.* 4. *Tiered assignments will be given to make sure students get the big ideas and the essential skills involved and the assignments will be given at different levels of complexity and open-ended ness. For example students who already know the concept of redox reactions are given a lab assignment in which they must develop and test hypotheses related to the topic, while other students are given more direct instruction on the concept. Students are given a choice that contains a list of possible activities they can complete to learn more about redox reactions. The activities include hands on activities to further explore electrochemistry like reading books, or watching a video .Students will be asked to research more on redox reactions from internet or u-tube & share with the class.*   *Accommodation: ELL-students: 1. Students use computer to type their exit tickets, quiz etc.*  *2. Teacher – student conference/ interview to assess the student learning and understanding of the concepts.* |

**Unit 5 :Electrochemistry (Grade 12U)**

Done by : Farah Farah & Shirley Easo

Culminating Activity & Assessment Tools

**Why is this unit important?**

We literally cannot live without electrochemistry because even for the proper cell functioning and transmission of signals through the nervous system we need electrochemical reactions. There are numerous and vital electrochemical processes in both nature and industry. Electrochemistry is extremely important in a wide range of technological applications, such as batteries for mobile devices and vehicles, the electroplating of objects with metals or metal oxides and the detection of alcohol in drunken drivers through the redox reaction of ethanol

**Culminating activity (Electrochemistry)**

In this activity, students (in groups of 3-4) will design an investigation in any one of the given topics. After the students are done with research, discussions, data collection, results, interpretations and conclusions, students will present their findings to the class. Only onegroup can work on each topic, if there are two groups choosing the same topic, then a draw will be used to determine which group works on which topic .(You can even come up with their own relevant topic).

**How to Collect Information?**

1. Decide on what you would like to find out about your topic. Write them down as research questions. Take the help of the essential questions to help you guide your investigations.

2. Search for information useful to answering your research questions.

3. Use various methods to collect information, e.g. surfing the net, reading books, journals and newspapers ,conducting experiments etc.

**Type of presentation**

Present your topic to the class in any form you choose for example ,RAFT, role play ,talk show ,PowerPoint presentation, Bristol board presentation, play, song, rap, etc. Whatever form you choose every aspect of the essential questions given below must be justified.

**Essential questions to guide your investigation**

1. Why did you choose this topic as part of your investigation? How is this topic related to electrochemistry?
2. Explain how do you relate the concepts you have learned in electrochemistry with your topic? Give possible half reactions, cell diagram, etc.
3. What are the health & safety issues related to this investigation?
4. What are some of the toxic substances that can escape from electronic waste into the environment? What are the potential effects of these poisons on our health?
5. Were there any problems associated with your investigation? How did you overcome these problems? Do you have any other information related to the topic that you would like to investigate.
6. Comment on the importance of your topic and identify the environmental, social , economic impact of this activity or process .

**Personal reflection:**

In addition to the group presentation, each student in a group is also required to provide an honest and accurate assessment (identifying strengths and weaknesses) of the experiences working in a group setting and contributions towards helping the group in completing the culminating activity

**List of topics** *(choose any one topic ☺)*

1. **Investigation into corrosion or corrosion prevention.**

Corrosion is an electrochemical process. Iron and steel structures are highly susceptible to corrosion and their protection costs billions of dollars annually Other examples of corrosion include the green deposit that forms on copper and bronze, called verdigris, a basic copper carbonate, and the tarnish on silver, which is a corrosion product - a film of black silver sulfide.

1. **History/ Timeline of electrolysis**

In chemistry and manufacturing, electrolysis is a method of using an electric current to drive an otherwise non-spontaneous chemical reaction. Electrolysis is commercially highly important as a stage in the separation of elements from naturally-occurring sources such as ores using an electrolytic cell.

History: 1800 - William Nicholson and Johann Ritter decomposed water into hydrogen and oxygen. 1807 - Potassium, Sodium, Barium, Calcium and Magnesium were discovered by Sir Humphry Davy using electrolysis. 1886 - Fluorine was discovered by Henri Moissan using electrolysis. 1886 - Hall-Héroult process developed for making aluminium 1890 - Castner-Kellner process developed for making sodium hydroxide

1. **A gas cracker :**

is any device that splits the molecules in a gas or liquid, usually by electrolysis, into atoms. The end product is usually a gas. A hydrocracker is an example of a gas cracker. In nature, molecules are split often, such as in food digestion and microbial digestion activity. A gas cracker device splits the molecule at a rate much greater than that normally found in nature. In science and industry, gas crackers are used to separate two or more elements in a molecule. For example, liquid water, or H2O, is separated into hydrogen and oxygen gases.

1. **High pressure electrolysis (HPE) :**

is the electrolysis of water by decomposition of water (H2O) into oxygen (O2) and hydrogen gas (H2) due to an electric current being passed through the water.

1. **Faraday Efficiency**

(also called faradaic efficiency , faradaic yield, columbic efficiency or current efficiency) describes the efficiency with which charge (electrons) are transferred in a system facilitating an electrochemical reaction. The word "faraday" in this term has two interrelated aspects. First, the historic unit for charge is the faraday, but has since been replaced by the coulomb. Secondly, the related faraday's constant correlates charge with moles of matter and electrons. This phenomenon was originally understood through Faraday's work and expressed in his Faraday's laws of electrolysis.

1. **Electrology**

is the practice of electrical depilation to permanently remove human hair. The actual process of removing the hair is referred to as electrolysis. The practitioner slides a solid hair-thin metal probe into each hair follicle. Proper insertion does not puncture the skin. Electricity is delivered to the follicle through the probe, which causes localized damage to the areas that generate hairs, either through the formation of caustic lye (galvanic method), overheating (thermolysis method), or both (blend method).

1. **Electrical system of the International Space Station**

The ISS electrical system uses [solar cells](http://en.wikipedia.org/wiki/Solar_cell) to directly convert sunlight to [electricity](http://en.wikipedia.org/wiki/Electricity). Large numbers of cells are assembled in arrays to produce high power levels. This method of harnessing [solar power](http://en.wikipedia.org/wiki/Solar_power) is called [photovoltaics](http://en.wikipedia.org/wiki/Photovoltaic) .

Since the space station is often not in direct sunlight, it also relies on rechargeable [batteries](http://en.wikipedia.org/wiki/Nickel_hydrogen_battery) to provide continuous power during the "eclipse" part of the orbit. The batteries ensure that the station is never without power to sustain life-support systems and experiments. During the sunlit part of the orbit, the batteries are recharged.

1. **Reducing pollution from electroplating**

Electroplating is a type of metal finishing operation that changes the surface properties of a metal part to make it stronger, shinier, and corrosion resistant .Electroplating operations can produce emissions of toxic air pollutants, including heavy metals and cyanide.

1. **Application of electrolysis in metallurgy**

Electrowinning is the oldest industrial [electrolytic](http://en.wikipedia.org/wiki/Electrolyte) process. The English chemist [Humphry Davy](http://en.wikipedia.org/wiki/Humphry_Davy" \o "Humphry Davy) obtained [sodium](http://en.wikipedia.org/wiki/Sodium) metal in [elemental](http://en.wikipedia.org/wiki/Chemical_element) form for the first time in 1807 by the [electrolysis](http://en.wikipedia.org/wiki/Electrolysis) of molten [sodium hydroxide](http://en.wikipedia.org/wiki/Sodium_hydroxide). The most common types of electrometallurgical processes are [electrowinning](http://en.wikipedia.org/wiki/Electrowinning" \o "Electrowinning) and electro-refining.

1. **All about batteries**

“A simple battery can be made by inserting a length each of a pair of metals into a lemon. Electrons flow from the more reactive to the less reactive metal through the medium of the lemon juice, producing a small amount of current.

Create a timeline to show the history of batteries. What methods should be used to dispose of depleted batteries? What impact has the unsafe disposal of batteries on society and the environment?

**ASSESSMENT RUBRIC**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Expectation | Criteria | Level 1 | Level2 | Level 3 | Level 4 |
| Knowledge  & understanding | Explains and relates the concepts learned in electrochemistry with the topic. Gives possible half reactions, cell diagram, etc.  –-Gives an accurate understanding of the redox reaction /cell diagrams (if any )involved in building the cell/ process etc. | With limited accuracy | With some accuracy | With considerable accuracy | With high degree of accuracy |
| Inquiry | Students incorporate soundness of arguments , conclusion ,originality & variety of methods and Inquiry  Justifies how half reactions/ resources / activities etc. are related to electrochemistry/ redox reactions  Conducts meaningful research and relevant use of available resources  Personal reflections | With limited accuracy | With some accuracy | With considerable accuracy | With high degree of accuracy |
| Communications | -Student organizes and correlates all observations ,inquires results etc. and communicated it in a relevant manner  – uses scientific language effectively throughout the report  Students expresses ideas and information and communicates for different audiences and purposes in oral, visual, and/ or written forms | communicates observations and results with limited clarity  uses scientific language with limited effectiveness | communicates observations and results with some clarity  with some  clarity | communicates observations and results with considerable clarity  with considerable  clarity | communicates observations and results with high degree of clarity  with high degree of clarity |
| Making connections | -Student could relate the topic to electrochemical reactions & electrochemistry.  - could analyse and evaluate the risks , benefits and impact on health & society  Student could discuss controversial issues / problems and identify  possible alternatives or solutions to improve the industry’s impact  Could make connections between science, technology, society and the environment | Student could relate with limited accuracy  -could analyse and evaluate the risks ,benefits and impact on health & society with limited accuracy  with limited accuracy | Student could relate with some degree of accuracy  -could analyse and evaluate the risks , benefits and impact on health & society with some degree of accuracy  with some degree of accuracy | Student could relate with some considerable of accuracy  -could analyse and evaluate the risks , benefits and impact on health & society with considerable degree of accuracy  with considerable degree of accuracy | Student could relate with high degree of accuracy  -could analyse and evaluate the risks , benefits and the impact on health & society with high degree of accuracy  with high degree of accuracy |

**Culminating activity : EVALUATION FORM**

|  |
| --- |
| 4=Excellent 3=Very Good 2=Fair 1=needs improvement  **Structure and Organization**  \_\_\_ Introduction is made interesting & engaging  \_\_\_ Introduction makes purpose, goals, clear  \_\_\_ Major ideas are clear/presentation is well organized  \_\_\_ Presentation parts create a unified whole  \_\_\_ Individual speakers refer to each other’s points/make transitions smoothly  \_\_\_ Presentation includes effective closure  **Content**  \_\_\_ Presentation speaks to the assignment guidelines/objectives  \_\_\_ Presentation reflects thoughtful, thorough research  \_\_\_ Supporting material is thorough/sufficient  \_\_\_ Speakers demonstrate genuine knowledge of topic  \_\_\_ Material is interesting/listeners feel they have genuinely learned  \_\_\_ References are cited/listed in bibliography  \_\_\_ An attempt is made to be creative and to connect well with audience  \_\_\_ Presentation & presentation materials are professional and appropriate in research  **Delivery**  \_\_\_ Presenters exhibit good conversational style/ delivery  \_\_\_ Presenters maintain effective eye contact  \_\_\_ Presenters exhibit enthusiasm /team work  \_\_\_ Group demonstrates audience awareness  \_\_\_ Presentation is equally distributed among group members |

**Project Checklist:**

The student checklist which will help students to track all the work done in a sequence.

|  |  |  |  |
| --- | --- | --- | --- |
| ***TASK*** | **DATE** | **YES** | **NO** |
| **Topic selected** |  |  |  |
| **Role selected** |  |  |  |
| **Audience invited** |  |  |  |
| **Presentation Format selected and organized** |  |  |  |
| **Each person has a role in the project**   * **Checklist ORGANIZER \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** * **Personal Reflection SUPERVISOR\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** * **Questions ORGANIZER \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** * **Production Administrator \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** * **Presentation Supervisor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** * **Event Manager** |  |  |  |
| **Involvement & contribution in completion and research of the project .** |  |  |  |
| **Overview of presentation is ready to show to the teacher** |  |  |  |
| **Final Outline of presentation is complete** |  |  |  |
| **Questions required are answered in presentation** |  |  |  |
| **Presentation is organized, practised and includes involvement of all group members** |  |  |  |
| **Personal Reflection is completed** | **After presentation** |  |  |

**CULMINATING ACTIVITY CHOICE BOARD**

|  |  |  |
| --- | --- | --- |
| *Verbal/ Linguistic*   * MCj03550110000[1]Prepare a report (max. 1000 words) * Write a newspaper column (max. one page, column format) * Critique a video/ movie * Prepare a “Rant” | *Musical/ Rhythmic*   * MCj04282570000[1]Create a song, rap * Write a commercial jingle * Create a power point/ SMART board presentation to music | *Visual/ Spatial*   * Create a mural, poster or drawing * MPj04373380000[1]Design a graphic organizer * Create a comic strip * Illustrate an event |
| *Logical/ Mathematical*   * MCj02790500000[1]Complete an audit/ balance sheet * Classify, rank and/ or compare (table format) * Design a game show * Describe a sequence or process | FREE  CHOICE | *Bodily/ Kinesthetic*   * Construct a model or representation * MCj04402390000[1]Work through a simulation of an environmental situation * Create a tableau * Create a play |
| *Naturalist*   * Adapt materials to a new use * Categorize material or ideas * MPj04373760000[1]Examine materials to make generalizations or make connections to nature | *Interpersonal*   * Dialogue/ debate a topic * Survey/ interview others on issue (s) and report your findings   MPj04331190000[1] | *Intrapersonal*  MCj03974900000[1]   * Write a journal entry in response to one of the issues (min. 250-300 words) |

**R.A.F.T**

***PRESENTATION OPTIONS***

|  |  |
| --- | --- |
| **ROLE** | * **Scientist** * **Chemist** * **Demonstrator** * **Science Centre exhibitor** * **Documentary** * **Sales Rep** * **Instructor** |
| **AUDIENCE** | * **Director of education** * **Director of research & development** * **Health director Media T.V production** * **News paper Advertiser** * **Media T.V production** * **News paper Advertiser** * **Science Students** * **Colleagues** * **Consumer**   **Principal**  **Science teachers** |
| **FORMAT** | * **Article** * **Brochure** * **Station set up** * **Demonstration** * **PowerPoint presentation** * **Websites** * **Bristol board** * **News letter** * **Video of role play** * **Poetry** * **Lecture** |
| **TOPIC** | **The given topics (choose one)** |

**Progress of work**

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Work completed/in progress | Students involved | Remarks  How is it going?  (Feelings ,problems ,solutions) |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Peer evaluation (During the presentation)**

**Provide a score from 1(poor) to 5 (excellent) for each of the presentation of your colleague . Circle clearly the desired score. Please do not write your own name.**

**Presentation 1: Presenter’s name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

A. Background was thorough 1 2 3 4 5

B. Idea of the work was clearly presented 1 2 3 4 5

C. Applications were relevant 1 2 3 4 5

D. Limitations and solutions were identified 1 2 3 4 5

E. Ability to answer questions 1 2 3 4 5

**F. OVERALL 1 2 3 4 5**

**Presentation 2: Presenter’s name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

A. Background was thorough 1 2 3 4 5

B. Idea of the work was clearly presented 1 2 3 4 5

C. Applications were relevant 1 2 3 4 5

D. Limitations and solutions were identified 1 2 3 4 5

E. Ability to answer questions 1 2 3 4 5

**F. OVERALL 1 2 3 4 5**

**Presentation 3: Presenter’s name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

A. Background was thorough 1 2 3 4 5

B. Idea of the work was clearly presented 1 2 3 4 5

C. Applications were relevant 1 2 3 4 5

D. Limitations and solutions were identified 1 2 3 4 5

E. Ability to answer questions 1 2 3 4 5

**F. OVERALL 1 2 3 4 5**

**Presentation 4: Presenter’s name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

A. Background was thorough 1 2 3 4 5

B. Idea of the work was clearly presented 1 2 3 4 5

C. Applications were relevant 1 2 3 4 5

D. Limitations and solutions were identified 1 2 3 4 5

E. Ability to answer questions 1 2 3 4 5

**F. OVERALL 1 2 3 4 5**

**Peer evaluation of members in your group only**

**Complete one evaluation form for all members of your group *including* yourself.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category For Evaluation | **Possible Scores** | | | | |
| 1 | 2 | 3 | 4 | **5** |
| **Quality of Work**: | Produces unacceptable work, fails to meet minimum group or project requirements. | Occasionally produces work that meets minimum group or project requirements. | Meets minimum group or project requirements. | Regularly produces work that meets minimum requirements and sometimes exceeds project or group requirements. | Produces work that consistently exceeds established group or project requirements. |
| **Team work & team spirit** | Behavior is detrimental to group .Provides no help whatsoever | Behavior is inconsistent and occasionally distracts group meetings. Provides help at times | Regularly projects appropriate team behavior including: listening to others, and allowing his/her ideas to be criticized. | Consistently demonstrates appropriate team behavior and provides help | Consistently demonstrates exemplary team behavior. |
| **Responsibility** & involvement | Is unwilling to carry out assigned tasks. | Sometimes carries out assigned tasks but never volunteers to do a task. | Carries out assigned tasks but never volunteers to do a task. | Consistently carries out assigned tasks and occasionally volunteers for other tasks. | Consistently carries out assigned tasks and always volunteers for other tasks. |
| **Leadership** | Does not display leadership skills. | Displays minimal leadership skills in team. | Occasionally assumes leadership role. | Regularly displays good leadership skills. | Consistently demonstrates exemplary leadership skills. |
| **Overall Performance Rating** | Performance significantly fails to meet group requirements. | Performance fails to meet some group requirements. | Performance meets all group requirements. | Performance meets all group requirements consistently and sometimes exceeds requirements. | Performance consistently exceeds all group requirements. |

**Additional Notes :**

Peer evaluation by the members of the same group is very important in situations where there are students who try to take the easy way out during group work by contributing minimally or nothing at all. It would also be great if sample templates for group contracts and log books for group tasks are provided. The students will then have to update these logs weekly.  [Sample template for group contract](http://wveis.k12.wv.us/teach21/cso/upload/UP3406WS9.doc) could be given for use as a guide in constructing their contract, particularly if students have no prior experience .It works extremely well when the [sample for group contract](http://wveis.k12.wv.us/teach21/cso/upload/UP3406WS9.doc) includes provisions for awarding bonus points for hard work and for leadership. This helps in motivating the students. Bonus points may then be added to the individual’s final project grade.

**References**

1. mgt.buffalo.edu/departments/mss/djmurray/mgs351/PeerEval.doc
2. [www.vcu.edu/cte/workshops/teaching\_learning/2009\_resources/P](http://www.vcu.edu/cte/workshops/teaching_learning/2009_resources/P)
3. <http://www.epa.gov/airquality/communitybase/guide/electroplating_comm_info.pdf>
4. <http://en.wikipedia.org/wiki/Extractive_metallurgy>
5. Gilchrist, J.D. (1989). "Extraction Metallurgy", Pergamon Press
6. http://classweb.gmu.edu/nclc110/f00/grp-pres-eval.htm

**ELECTROCHEMISTRY**

**SCH 4U**

**Unit Test**

**Name: Date:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Knowledge**  **&**  **Understanding** | **Thinking**  **&**  **Inquiry** | **Communication** | **Application** | **TOTAL** |
| **/15** | **/20** | **/ 10** | **/ 10** | **/ 55** |

**This summative has 22 questions that cover all four categories of the Achievement Chart. You have 75 minutes to complete it.**

**TIMELINE**

**2min Quickly review the test and jot down any necessary notes if you need to**

**25min KNOWLEDGE and UNDERSTANDING**

**• Multiple Choice, True/False**

**20min THINKING and INVESTIGATION– only answer 2 of the 3 questions**

**• Short Answers, Calculations**

**10min COMMUNICATION**

**• Long Answers, Diagrams**

**10min APPLICATION–**

**• Short Answers**

**8min REVIEW test**

**Section 1:**

|  |
| --- |
| **KNOWLEDGE & UNDERSTANDING**  **Marks / 15** |

**Multiple Choice : (10 marks)**

**Choose the best answer: (1 mark each)**

1. Oxygen atoms in a compound normally have an oxidation number

|  |  |
| --- | --- |
| a. | of 0, which is why they are called oxidation numbers |
| b. | of 2+, like the ion would be in an ionic compound |
| c. | 2–, like the ion would be in an ionic compound |
| d. | that depends on the other atoms in the compound |

2. In the reaction equation Co(s) + 2 HCl(aq)  CoCl2(aq) + H2(g),

|  |  |
| --- | --- |
| a. | chlorine is oxidized |
| b. | hydrogen is reduced |
| c. | hydrogen is oxidized |
| d. | cobalt is reduced |

Hg2+(aq) + 2 e–  Hg(l),  = +0.80 V

Ag+(aq) + e–  Ag(s),  = +0.80 V

Cu+(aq) + e–  Cu(s),  = +0.52 V

Cd2+(aq) + 2 e–  Cd(s),  = –0.40 V

3. Use the list of half-reactions and reduction potentials above to select the entity that would react spontaneously with silver metal.

|  |  |
| --- | --- |
| a. | silver ion |
| b. | mercury ion |
| c. | copper ion |
| d. | cadmium ion |

Cr2O72–(aq) + I–(aq)  Cr3+(aq) + IO3–(aq)

4. From the unbalanced equation above, what is the correct balanced half-reaction equation for the oxidation half-reaction in an acidic medium?

|  |  |
| --- | --- |
| a. | I–(aq) + 3 H2O(l)  IO3–(aq) + 6 e– + 6 H+(aq) |
| b. | I–(aq)  IO3–(aq) + 6 e– |
| c. | Cr2O72–(aq) + 6 e– + 14 H+(aq)  2 Cr3+(aq) + 7 H2O(aq) |
| d. | Cr2O72–(aq) + 3 e–  Cr3+(aq) |

5. Which of the following is the correct line notation for the galvanic cell that involves this redox reaction?



|  |  |
| --- | --- |
| a. | Cu2+(aq)|Cu(s)||Ni(s)|Ni2+(aq) |
| b. | Cu(s)|Cu2+(aq)||Ni2+(aq)|Ni(s) |
| c. | Ni(s)|Ni2+(aq)||Cu2+(aq)|Cu(s) |
| d. | Ni2+(aq)|Ni(s)||Cu(s)|Cu2+(aq) |

6. Which of the following is a feature of the standard hydrogen half-cell?

|  |  |
| --- | --- |
| a. | 1.0 mol/L HCl(aq) |
| b. | a zinc electrode |
| c. | hydrogen gas at 120 kPa |
| d. | a temperature of 373 K |

7. Copper has a half-reaction reduction potential of +0.34 V, and cadmium has a half-reaction reduction potential of –0.40 V. Which of the following statements is correct regarding a copper-cadmium galvanic cell?

|  |  |
| --- | --- |
| a. | Copper is the anode, cadmium is the cathode, and the cell potential is +0.74 V. |
| b. | Copper is the cathode, cadmium is the anode, and the cell potential is +0.74 V. |
| c. | Copper is the cathode, cadmium is the anode, and the cell potential is +0.06 V. |
| d. | Copper is the anode, cadmium is the cathode, and the cell potential is –0.06 V |

8. From the information given below, what is the combination of electrodes that would generate the greatest voltage?

 *E*= –1.18 V

 *E*= –0.76 V

 *E*= –0.14 V

 *E*= +1.20 V

 *E*= –0.28 V

|  |  |
| --- | --- |
| a. | Pt–Mn |
| b. | Mn–Zn |
| c. | Pt–Co |
| d. | Co–Mn |

9. What substance(s) play(s) a part in the corrosion of iron?

|  |  |
| --- | --- |
| a. | water |
| b. | an electrolyte |
| c. | oxygen |
| d. | all of the above |

10. Copper metal can be obtained from Cu 2+ ions by

I electrolysis of aqueous copper (II) sulphate solution

II immersing a piece of silver metal in aqueous copper (II) sulphate solution

III adding zinc powder to aqueous copper (II)sulphate solution

IV passing hydrogen gas through heated copper (II)oxide

A I & III only

B I, II and III only

C I,III & IV only

D II ,III & IV only

**PART B:**

**Modified True/ False : (5 marks)**

**Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.**

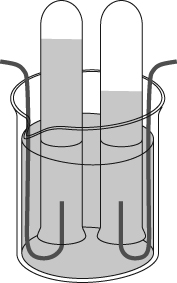
\_\_\_\_ 1. **The oxidation number of an atom in an element is zero. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_ 2. The half-reaction Cu(s)  Cu2+(aq) + 2 e– represents oxidation. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_ 3. To balance a redox reaction equation in basic solution, you must first balance it in acidic solution. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_ 4. The strongest oxidizing agent in a galvanic cell is above the strongest reducing agent in the redox table, producing a cell potential that is negative. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_ 5. Water will undergo electrolysis to produce hydrogen and oxygen gas, as shown in the following image. The gas tube on the left contains hydrogen gas.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

****

|  |
| --- |
| **THINKING & INVESTIGATION (20 marks)** |

**1.. A voltaic cell consists of a copper electrode in a solution of copper (II) ions**

**and a palladium electrode in a solution of palladium (II) ions. The palladium**

**is the cathode and its reduction potential is 0.951 V.( 6 marks)**

1. **Write the half-reaction that occurs at the anode.(2)**

**(b)If E° is 0.609 V, what is the potential for the oxidation half-reaction?(2)**

**(c) What is K eq for this reaction ? (2)**

1. **5.77 g of zinc is deposited at the cathode when a current of 7.1 amperes passes through an electrolytic cell for 40 minutes. What is the oxidation state of the zinc in the aqueous solution? (4 marks)**
2. **Create an illustration showing how four cells should be connected in series to provide energy to light an electric bulb.**

|  |
| --- |
| **COMMUNICATION (10 marks)** |

1. **The following diagram shows a cell for electroplating a spoon with silver.**

**( 5 marks)**



1. **(a) Label the anode and cathode.**
2. **(b) Explain how the spoon is electroplated and why there is no need for a salt bridge.**

|  |
| --- |
| **SOLUTION:** |

**2. From the information given, a student determines that a spontaneous reaction does not occur when solid gold is placed in an acidic medium.**

**Au3+(aq) + 3 e– Au(s); = +1.50 V**

**2 H+(aq) + 2 e– H2(g); = 0.00 V**

**Is the student correct? Explain your answer (5 marks)**

|  |
| --- |
| **SOLUTION:** |

|  |
| --- |
| **APPLICATION (10 marks)** |

**21. A zinc electrode and a 1.0 mol/L solution of zinc nitrate are used to make a half cell . Another half cell is constructed using a nickel electrode and a 1.0 mol/ L solution of nickel (II) nitrate. (10 marks)**

**a) Draw the galvanic cell that could be constructed from these half cells. Label the anode, cathode, the salt bridge, and the direction of the electron flow. (4)**

**b) Write equation for the half reaction that occurs at each electrode. (2)**

**c) Write the net ionic equation. (2)**

**d) Use cell notation to summarize this cell.**

**References**

[http://http-server.carleton.ca/~rburk/chem1000/on\_line\_tuts/electrochemistrytest.htm](https://sn2prd0310.outlook.com/owa/redir.aspx?C=M4-90xgLMk28Z-QsJfgDBMCyS5_5Ps8Iomu_VYwdN7X-5bP1fTMQ2xlU_Kgh9NuaW4IVMrD1hAY.&URL=http%3a%2f%2fhttp-server.carleton.ca%2f%7erburk%2fchem1000%2fon_line_tuts%2felectrochemistrytest.htm)

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