**Life Support Systems (Lesson 3 of 3)**

**Oxygen Generation Methods for Life Support Systems**

**STEM Topics -** Electrolysis, Enzymes, Chemical Reactions, Photosynthesis

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**Grade Level:** 6-8 Grade

**Goals**: Learn about the processes available to make oxygen from resources like water, chemicals and biological material that can be used for an oxygen generation life support system.

**Learning Objectives:**

1. SWBAT visualize how the life support systems interconnect with one another through an activity
2. SWBAT understand the process of electrolysis and operate a simplified electrolysis reactor with simple materials
3. SWBAT explore other methods of producing oxygen through chemical or biological means taught as a demonstration or hands on activity

**Materials:**

Power points:

Life Support Systems Connected.pptx

Oxygen Generation.pptx

Documents:

Life Support Systems Flow Chart Blank Sheet.doc

Life Support Systems Pieces.doc

Diagram of Electrolysis.doc

Life Support Systems Flow Chart Answers.doc

Materials for Electrolysis Experiment (for each student):

1 9V battery

2 metal spoons

2 cut out 2 L plastic juice containers (cut until starts to rise to opening)

2 blank 3” x 5” notecards with pen

Scotch tape and scissors

2 2 oz cups of non-iodized salt

2 2 oz cups of baking soda

1 pair of rubber gloves

Demonstration Materials for Chemical Generation of Oxygen:

1 - 3 - 3 mL syringe (better to use 10 or 20 mL syringe)

1 - 3 - 4 oz cup/container

3 500 mL bottle filled with ~ 50 – 75 mL of 3 % Hydrogen Peroxide in them

150 - 200 mL Bleach

Scotch tape

3 Balloons

Demonstration Materials for Biological Generation of Oxygen:

1 medium sized potato & peeler (peel just before using)

1 knife & cutting board

2 500 mL bottles with 100 – 150 mL of 3 % hydrogen peroxide in them

2 Balloons

Instructional Videos:

Electrolysis Experiment.mp4

**Vocabulary:**

**Electrolysis:** The passage of an electric current through an electrolyte with subsequent migration of positively and negatively charged ions to the negative and positive electrodes. This results in the generation of gases such as oxygen and hydrogen at the electrodes

**Electrolyte:** A liquid that contains ions that carry electric charges.

**Chemical Generation of Oxygen:** The mixture of two chemicals that are liquids creates a reaction that forms oxygen (oxygen bubbles are made).

**Catalase:** An enzyme that reacts with hydrogen peroxide to produce water and oxygen. It is often found in living organisms like potatoes.

**Setup:**

1.Begin by reviewing the power point lesson **Life Support Systems Connected.pptx** and get yourself familiar with all the flowcharts in the slide presentation and how the life support systems fit together. Next, review the files **Life Support Systems Flow Chart Blank Sheet.doc, Life Support Systems Pieces.doc** and **Life Support Systems Flow Chart Answers.doc** to see how to operate the Life Support Systems connecting game. The blank sheet and pieces sheet could be made as hard copies and one could have the students cut out the pieces by scissors, and glue them in the blank spots. Alternatively, the game could be played on the computer for each student. They should be able to cut or copy and paste each game piece from the Life Support Systems Pieces.doc into the Life Support Systems Flow Chart Blank Sheet.doc file. Go over what the answers are for the game using the Life Support Systems Flow Chart Answers.doc sheet. If it appears the tasks may be too complex for the students, then the instructor could take charge of the matching/connection game and guide the students on where to put the pieces on the blank sheet.

2.Review the power point lesson **Oxygen Generation.pptx** in order to know the concepts to be taught about electrolysis and other methods of making oxygen that are based on biological or chemical means. Note in the presentation where you introduce what an electrolysis unit looks like. Then review the **Diagram of Electrolysis.doc** in order to know what the students are going to draw when you arrive at this slide in the lesson.

3.Next, gather together all of the materials for the rest of the demonstrations and student experiments that will take place in the lesson. Place the pieces for the electrolysis experiment nearest to you, followed by the equipment for the chemical generation of oxygen and then lastly for the generation of oxygen through catalase. Verify that you have all the pieces you need for the experiments.

4. To prepare for the electrolysis experiment first watch the instructional video **Electrolysis Experiment.mp4.** Go through the experiment once yourself following the steps as outlined from the video recorded below in step x of the procedure. Once that experiment is done, go through the other two demonstrations before teaching them. Unfortunately, there is no video for the other two experiments as these are meant to be demonstrations done in front of the students, but with the proper safety precautions (goggles and gloves for handling of bleach and hydrogen peroxide) they could also be experiments that the students could do as well. Follow the instructions given below for both the Biological Generation of Oxygen and the Chemical Generation of Oxygen.

**Lesson Plan Procedure:**

1.Begin the lesson by presenting the concepts outlined in the **Life Support Systems Connected.pptx** power point file. It starts by presenting some biomes found in the Biosphere 2 project close to Tucson, AZ. It then shows how the specific life support systems work together or are connected together and also gives some images of how they are all connected as a flow chart system. This is where you introduce the idea that they will do a game/activity where they put the pieces containing the names of the life support systems into the blank sheet shown on slide 5 or it can be done as a drawing activity as said in the slides or on the computer, it is your choice. Slides 4 and 6 show what the completed activity should look like when it is completed. The last three slides demonstrate how the life support system is cyclical or how it is used to recycle air and water. They connect as a circuit such as one output as the input to another. [15 minutes].

2.Have the students work with the Life Supports Systems Connected Activity which was just discussed previously. There are three options for this game. One, the students can be given a blank sheet of paper and then be shown the blank life support systems template where they draw out all the boxes. They then look at the game pieces (names of life support systems in boxes) and decide where they go, once they go. Once they have all the pieces correct they then color in the boxes with the names with colored pencils. The second option is to give them hardcopies of **Life Support Systems Flow Chart Blank Sheet.doc** and **Life Support Systems Pieces.doc**. They then cut out the pieces with scissors in the Life Support Systems Pieces.doc. After gathering all the loose life support system pieces, they arrange them in the boxes where they think they go. The instructor then goes over the answers and they rearrange their pieces in the blank spaces until they are correct. Afterwards they will glue in those pieces to the blank flow chart sheet. The third option is to give the students the above two sheets as computer files they download. They then can cut and paste by computer function each of the pieces to the correct blank spaces. If they get ones wrong, they can always recut and paste to other spots. [20 minutes].

3.Next, start teaching the powerpoint lesson **Oxygen Generation.pptx**. You will use this power point to help you do the electrolysis experiment and then the two demonstrations (or other experiments if you wish) of Chemical and Biological Generation. After covering the first two slides you will get into Electrolysis. Use the figure in the slide to help explain the process of electrolysis. Afterwards, temporarily stop the presentation in order to have the students draw out an electrolysis unit. Give them blank white paper, pencils and colored pencils. Then give each student a hardcopy of the **Diagram of Electrolysis.doc** and request of them to draw out this electrolysis unit from the hardcopy as best as they can. [20 minutes]

4. Now, go back to the Oxygen Generation.pptx lesson and present the next 3 slides (slides 5 – 7). In these slides the terms of electrolyte will be presented along with the equipment for the experiment that they will use and also some rudimentary instructions they you will introduce to the students. Next, after you have reviewed the video **Electrolysis Experiment.mp4** ahead of time, show this video to the students while you are executing the electrolysis experiment. Before starting the experiment and the video make sure all of the students have the equipment they need including gloves if you need. Steps in the video: (1) Go over materials for the experiment 0:00 – 1:52, (2) Explaining the concepts of Electrolytes to the students 1:53 – 4:18, (3) Fill up both bottles with distilled water 4:19 – 5:55, (4) Add 3 scoops of baking soda and stir it in 5:56 – 7:29, (5) Fit spoons to the battery terminals to start electrolysis and watch for bubbles 7:30 – 8:50, (6) Add 3 scoops of salt to container and fit spoons to battery terminals and watch for bubbles 8:51 – 11:22, (7) Add another 3 scoops of baking soda to first container, fit spoons to battery terminals and watch it bubble 11:23 – 14:40, (8) Add 3 scoops of salt to the second container, fit spoons to battery terminals and watch it bubble 14:41 – 15:55, (9) Write out observations for each electrolysis unit for 3 and 6 scoops of salt or baking soda in the data table provided. [30 minutes].

5.During the remaining portion of the Oxygen Generation.pptx lesson, the demonstrations of Chemical Oxygen Generation and Biological Oxygen Generation will take place. Since there are no instructional videos for this portion, the instructions will be listed here and below. Starting with Chemical Oxygen Generation. One will need from 1 – 3 500 mL bottles filled with about 50 mL of preferably bleach (but you could switch and use hydrogen peroxide instead). You just switch the chemical that you’re injecting into each of the bottles. For my demonstration I decided to use a 3 mL syringe but it is recommended to have a 10 – 20 mL syringe so that you execute less filling steps into the bottle. On each bottle put a large black dot with a marker about halfway up the bottle. Cover this with tape and fold it up so that you can keep removing and recovering it with the tape afterwards. For three bottles you may want to add a total of 20, 40, 60 mL of hydrogen peroxide (or bleach), for two bottles 30 and 60 mL and for one bottle 40 mL. So in these instances it is recommended to use a large syringe. The idea is to cover the mouth of a bottle with a balloon. You then add hydrogen peroxide to the bleach in the bottle in steps of different amounts. You should see bubbles forming when you add the other chemical and the idea is that the balloon should start filling up the more you add hydrogen peroxide (or bleach) to it. The best way to ensure this happens is to effectively cover the hole you put the syringe into with tape securely and try to use a larger syringe so that less refilling steps are needed. The idea with the multiple bottles is that there comes a point where the two chemicals stop reacting (probably when you get to 50 mL) and you should see no more bubbles forming. This gets into concepts such as stoichiometry if you want to cover that area.