

## The Air Up There, Lesson Review

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“The Air Up There” is an activity developed by JPL for grades 10-12 (see link in references). It not only aims to teach students about the inner workings and importance of air filtration on the ISS, but does so using stoichiometry-finally answering the question “when will we ever use this?” The background information provided with the lesson is interesting, informative and authentic. I went through it with my students to start the lesson and also talked with them about MOXIE.

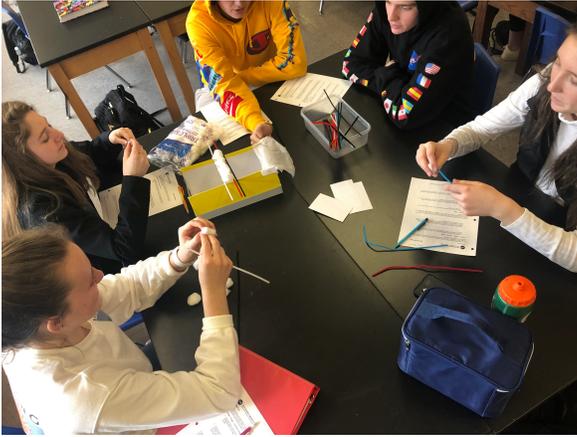
The lesson went well, but would have been better about 4 weeks ago while we were in the trenches of learning stoichiometry. It was easy to implement; the hardest part was finding a couple of shoeboxes. The rest of the materials are readily available, even in rural Maine. I would recommend using a hairdryer. The small fan I have was not strong enough, but I had both ready to use and the hairdryer was much better at getting the “CO<sub>2</sub>” flying. For CO<sub>2</sub> I used coffee grounds. I think cocoa powder would work better (as suggested) because it is lighter.

After introducing the lesson the students were actually okay with going back to stoichiometry for a day, but only because they were intrigued. I split them into 3 groups and gave them the materials, although I wasn't sure how much of each they would need and they ended up not using most of what I gave them. Most of the students really enjoyed the design and testing portion and had no problem collecting the data. They were not thrilled about doing the problems, but it was informative for me to see who remembered what they were doing and who still didn't grasp stoichiometry.

They were all able to do question 1 without direction from me, but then unable to take question 2 the one step further for calculating the number of cartridges. With only one hint (think about how we get to moles from gram-gram calculation) most were able to figure it out. The class was 72 minutes long, but we ran out of time, and did not get to the extension questions. I plan to use them later for review and as a reminder that stoichiometry is not going away anytime soon.

The overall feedback from the students was very positive. They said “I liked it,” “it was chill,” and “ugh more stoichiometry?” One student, my daughter, said she did not like it at all because she would rather just solve problems and not have to build something. My favorite, overheard, conversation was while one group was working on the last few problems and one student said “yeah, but if you’re really in space....” This is definitely an activity I will add to my curriculum plan to next year for the stoichiometry unit. I am excited that I have a cool answer to how it is used in the real world and find that tying the contest to this NASA activity generates immediate buy in from the students.

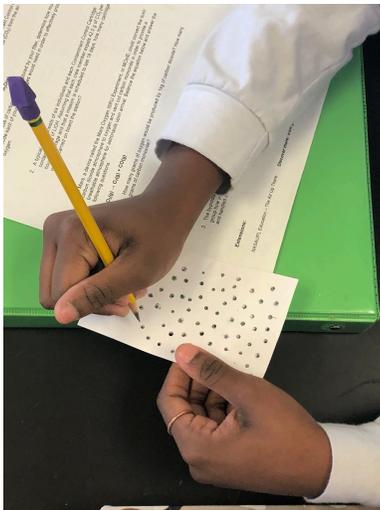
Group 1 of 3 brainstorming ideas:



Group 2 putting their filter together:



Group 3 taking a different approach:



Finding the mass after collecting "CO2" (group 2):



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**The Air Up There**

**Problem set:**

On the International Space Station, a device called the Contaminant Control Cartridge, which contains lithium hydroxide (LiOH), removes carbon dioxide (CO<sub>2</sub>) from the air. This process is represented by the following equation:

$$2 \text{LiOH}(s) + \text{CO}_2(g) \rightarrow \text{Li}_2\text{CO}_3(s) + \text{H}_2\text{O}(g)$$

1. Using the mass of carbon dioxide captured by your filter, determine how much lithium hydroxide each of your filter cartridges would need in order to effectively produce oxygen.

*coffee = 0.02*

0.02 g CO <sub>2</sub>	1 mol	2	23.71 g LiOH	14.35
	44.01 g	1	1 mol	44.01
<b>= 0.022 g LiOH</b>				

2. A typical crew consists of six individuals and each Contaminant Control Cartridge contains 750 g of LiOH. Assuming that each crew member expels 42.0 g of CO<sub>2</sub> per hour on average and that a mission is scheduled to last 18 days, how many cartridges must be carried on board the station?

42 g CO <sub>2</sub> /person	18 days	6 people	750 g LiOH
108,264 g	1 mol	2	1
	44	1	7,500,000
<b>= 158.25 car.</b>			

On Mars, a device called the Mars Oxygen ISRU Experiment, or MOXIE, could convert the toxic carbon dioxide atmosphere to oxygen and vent out carbon monoxide in order to provide a breathable atmosphere for astronauts upon arrival. Balance the equation below and answer the following questions:

$$\text{CO}_2(g) \rightarrow \text{O}_2(g) + \text{CO}(g)$$

1. How many grams of oxygen would be produced by 1 kg of carbon dioxide? How many grams of carbon monoxide?

1,000 g CO <sub>2</sub>	1 mol	1	32 g	28.01	= 363.6 g O <sub>2</sub>
	44.01 g	2	1 mol	14.08 g	= 318.2 g C

2. Presently, MOXIE is capable of producing oxygen at a rate of 12g per hour. If the astronauts require 30kg of oxygen per month, how many days would MOXIE have to run in order to supply one month's worth of oxygen?

30,000 g O <sub>2</sub> /mo	12 g/hr
288 g/day O <sub>2</sub>	
<b>= 104.17 days</b>	

3. The byproduct of MOXIE, carbon monoxide, is also very poisonous. Discuss with your group how you could design a system to be sure CO is kept away from the astronauts and handled safely.

Calculations from Group 1, who collected .3g "CO2"

### References

The Air Up There: Making Space Breathable Activity. (2017, January 20). Retrieved from <https://www.jpl.nasa.gov/edu/teach/activity/the-air-up-there-making-space-breathable/>