Submarines: Where's the Chemistry?

Developed by Mary Harris, Chemistry Teacher, Robert E. Fitch High School
Groton CT, http://www.groton.k12.ct.us/Domain/98
2014 Submarine Force Museum & Historic Ship *Nautilus*
STEM-H Fellowship

STEM Career Tool: Navy.com

Standard: Common Core, Integration of Knowledge and Ideas

CSS.ELA-Literacy.RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Objective: Students will use a guided web search to investigate submarine systems which can be linked to general chemistry topics. Students will produce a document which includes images and text, which answers nine 'scavenger hunt' questions.

Chemistry Scope: Elements, materials, reactions and compounds, energy transformations
Resources: Students working in pairs will need a laptop with internet access and an email account.

Activity Description: Students log in to the teacher web page and open the assignment, also attached below.

Students create a word document and copy the questions from the assignment into their document.

Teacher then explains that many of the chemistry concepts the class has been studying are used in everyday life on a submarine.

Teacher guides students to the Submarine Force Museum and Historic Ship *Nautilus* (SSN571) website (http://www.ussnautilus.org/education/index.shtml) and guides them to the virtual tour.

Allow time for students to visit each portion of the virtual tour. Ask if they noticed any chemistry in what they saw.

Demonstrate searching and writing the answer for the example question, included in the activity below.

Historic Ship *Nautilus* (SSN 571) moored in the Thames River, Groton, CT.

Submarine Chemistry Scavenger Hunt Activity

For an introduction to life on a submarine, take the virtual tour of the USS Nautilus (http://www.ussnautilus.org/virtualTour/index.shtml). Make sure you visit everything from the front walk to the crew's mess.

Next, the questions below will connect chemistry ideas (elements, materials, reactions, energy) to life on a submarine. Search for answers using navy sites like:

http://usnavymuseum.org/ the Cold War Gallery,

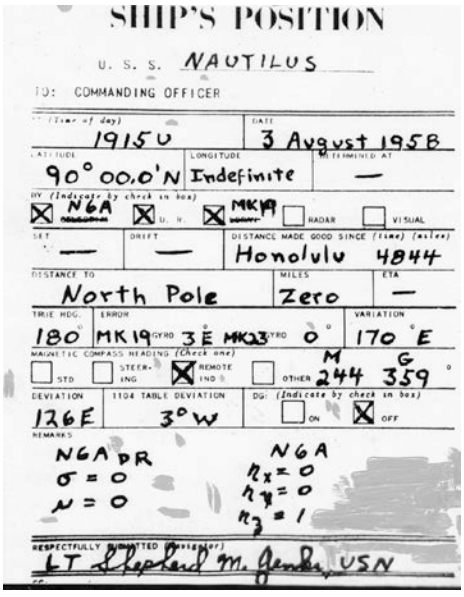
(http://www.youtube.com/user/coldwargallery/videos Cold War Gallery Youtube channel,

or http://www.navy.mil/navydata/cno/n87/today.html ,

or Wikipedia or Google images.

The best answers will include an illustration (picture, schematic, or video clip with a link) and text written in your own words (with a link to the source).

USS *Nautilus* arrives in New York harbor, after completing her transit beneath the North Pole as shown on the Ship's Position report for 3 August, 1958.



SHIP'S POSITION

U. S. S. NAUTILUS

TO: COMMANDING OFFICER

1915 U	3 August 1958	
90° 00.0' N	Indefinite	—
NGA ☒	MK19 ☒	RADAR ☐ VISUAL ☐
—	—	Honolulu 4844
North Pole	Zero	—
180°	MK 19 GYRO 3 E MK 23 GYRO 0°	170° E
STD ☐ STEERING ☐ REMOTE IND ☒ OTHER ☐	M 244 G 359	
126 E	3° W	DG: (Indicate by check in box) ON ☐ OFF ☒

REMARKS

NGA DR
σ = 0
ν = 0

NGA
$n_x = 0$
$n_y = 0$
$n_z = 1$

RESPECTFULLY SUBMITTED (Navigator)
LT Shepherd M. Gendr, USN

Example question and answer:

Q. Where might the element beryllium (Be) be found on a submarine?

A. http://en.wikipedia.org/wiki/Beryllium#Nuclear_applications) Beryllium has physical properties (high specific heat and thermal conductivity) that make it useful as a heat shield in the tip of missiles or to help control nuclear reactions in weapons.

http://www.youtube.com/watch?v=1aPvGGvnAGQ&list=UUGiS44OoLuJJIiAWk341OAw

Now it's your turn!

Q1. Where does most of the oxygen (diatomic element, O_2) for breathing come from on a submarine?

Q2. How is the element uranium (radioactive isotope U_{235}) used on a nuclear-powered submarine?

Q3. What kind of metal is a submarine's hull made of?

Q4. What is hopcolite and how is it used on a nuclear submarine?

Q5. What is zircaloy and how is it used on a nuclear submarine?

Q6. a. Write a balanced chemical equation for making oxygen from water.
b. Write a balanced chemical equation for making emergency oxygen from a chlorate candle.

Q7. Explain the three main sections of the nuclear power plant, found in the "Pressurized Water Nuclear Reactor" on a modern nuclear submarine (reactor, pressurizer, coolant "loops").

Q8. Explain the steps that happen in a submarine to convert potential energy (stored in the nuclei of uranium atoms) to the following:
a. Kinetic energy (for propulsion)
b. Electricity (to run a submarines electrical-powered systems)
c. Lead-acid main storage batteries (as back-up electrical power)

Q9. List five new vocabulary words and their definitions from your searching today.

Extension:
Compare and contrast the chemistry on a submarine with that on the space station.

When your document is complete and you have proof-read your written responses, email it to the teacher, or turn-in as directed. Please, make sure your name(s) are on both the email and your attached document.