

# Nuclear Submarine Class: Victor Smith and Dr. Michael Clarke

## Teacher's Guide

### Goals

- To help students understand what nuclear chemistry is
- To share real-life applications of nuclear chemistry

### About the Class

Dr. Michael Clarke brings Victor Smith, a nuclear submarine expert, to class. He explains to the students about nuclear fission reactors and about the nuclear chemistry which yields power for producing electricity. Dr. Clarke hopes that bringing a real-life situation to class might help to make the connection between micro and macro processes in chemistry.

### Lecture Notes—Victor Smith

When I say nuclear energy, what comes to mind?

Do you know what a nuclear reactor actually does? Produces power.

What types of nuclear reactors are there? Fusion and fission.

What are the differences between the two? Fusion: combine elements on the nuclear level, fuse them; Fission: split atoms and separate them into two different elements.

How many commercial fusion reactors are there in the world? Zero, this reaction occurs only in the sun. All commercial reactors are nuclear fission reactors.

What is the fuel for a nuclear fission reactor? Plutonium and uranium— $U_{235}$ .

How powerful is  $U_{235}$ ? Very powerful—on one tank of gas you can drive 300-400 miles, on one uranium pellet you can drive 5,000 miles.

How do we cause  $U_{235}$  to undergo fission? By adding neutrons to it, changing it to  $U_{236}$ . This is an unstable element that would undergo fission and become two different elements that are not always the same. We also get gamma ray radiation and 2-5 neutrons, which can get back into the reactor and begin the process again. We also get energy in the form of heat.

What is this process called? Chain reaction.

What kind of steam comes out of the reactor? Superheated steam. The steam can cut your arm off.

There are a lot of precautions we have to take to operate a nuclear reactor because it is very dangerous. This is why the Navy takes only top people for this.

### Teaching Tips From Dr. Clarke

In nuclear chemistry, solve problems about balancing nuclear equations, mass-defect, and binding energy.

I want the students to understand that knowledge is universal and that the teacher is not the only source for knowledge.

I want them to talk with someone who actually works in nuclear chemistry, because for me as a teacher in the classroom it is not as real.

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They didn't seem to transfer much of the knowledge that they discussed with me to the situation with the speaker, but this is why it is important to get different people in—so students can practice transfer of knowledge.

Knowledge they get in chemistry class is transferred to real life. That transfer is very important.

Someone who works in the field can tell stories of right and wrong. I can't tell them why the reactor exploded.

I think it is a good way for them to make the connection between the atomic world and the macro world. What happens within the atom, to the nucleus which is used, to generate electricity for a nuclear submarine. Hopefully they will see these connections.

### References: Links

<http://www.atomicarchive.com/>

This excellent site has a wealth of information for students and teachers. Many of the pages are interactive. Some require Flash Player.

<http://www.howstuffworks.com/nuclear-power1.htm>

A brief tutorial on nuclear power with some simulations and links to related topics.

### References: Readings

Olbris, D.J., and Herzfeld, J. (1999) "Nucleogenesis! A Game With Natural Rules for Teaching Nuclear Synthesis and Decay," *Journal of Chemical Education*, Vol. 76, No. 3, pp: 349-352.

Crippen, K.J., and Curtright, R.D. (1998) "Modeling Nuclear Decay: A Point of Integration Between Chemistry and Mathematics," *Journal of Chemical Education*, Vol. 75, No. 11, pp: 1434-1437.