NAME DATE

Handout 1:
Unit Overview

Should you purchase foods that have been irradiated? What's radon, and what should you do if you have it in your basement? Should your town permit the construction of a nuclear power plant?

To answer these questions, and many more that you will face as a citizen, consumer, patient, homeowner, employee, or family member, you need to understand an area of science called nuclear chemistry. Nuclear chemistry is the study of reactions in which the nucleus of an atom changes.

Your work in this unit will revolve around the following questions:

- *How do people put the power of the nucleus to work in a variety of useful applications?*
- *How can I find and evaluate the information I need to make good decisions about science-based societal issues?*
- *How can arts and media be used to communicate with the public about science-based societal issues?*

Unit Project

You will create a piece of media—such as a brochure, poster, Web site, or public service announcement—about a political, environmental, or health issue related to nuclear chemistry. In your project, you may try to educate others about an issue by presenting an unbiased picture, or you may advocate for a particular perspective on an issue.

What You Will Do in This Unit

Learn about nuclear chemistry. Through a variety of experiences, such as lab activities, animations and simulations, and classroom discussions, learn about the types of nuclear reactions, the energy released during those reactions, and the effects of this energy on living things.

Analyze different sources of information about science-based societal issues. Read news articles, opinion pieces, and other information sources and learn how to decide if what you read can be trusted.

Create an informative or persuasive media project. Working as part of a team, create a brochure, poster, Web site, public service announcement, or other media project that informs or persuades young adults about a possibly controversial topic related to nuclear chemistry.

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Vocabulary Used in This Unit

Nucleus: The positively charged center of an atom, which contains protons and neutrons. Plural: nuclei.

Isotopes: Atoms of the same element (same atomic number, same number of protons) that have different numbers of neutrons and therefore different atomic masses. Isotopes are represented by using the atomic symbol followed by the number of neutrons. For example, U-235 is an isotope of uranium with 235 neutrons, and U-238 is an isotope of uranium with 238 neutrons.

Radiation: Transfer of energy as waves or particles traveling through a medium or through empty space.

Ionizing radiation: Radiation with enough energy to create ions (charged atoms) by removing electrons from atoms.

> **Note:** Strictly speaking, radiation includes both ionizing radiation and non-ionizing radiation, but in common usage, the word *radiation* often refers only to ionizing radiation. Non-ionizing radiation includes radio waves, microwaves, and visible light.
>
> The word *radiation* is also sometimes used to refer to *radiation therapy*, which is the use of radioactive materials to treat diseases such as cancer.

Radioactivity: The process in which an unstable atomic nucleus gives off ionizing radiation, such as alpha particles, beta particles, and/or gamma rays.

Radioisotopes: Isotopes that are radioactive.

Irradiation: Exposure to ionizing radiation. Irradiation does not usually result in the target becoming radioactive, but damage to the target can occur.

Half-life: The time it takes for half of the atoms in a sample of a radioisotope to decay.

Fission (nuclear fission): The splitting of an atomic nucleus into two smaller nuclei of approximately the same size.

Fusion (nuclear fusion): The merging of two or more atomic nuclei to create a single heavier nucleus.

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Handout 2:
The Power of the Nucleus Project Description

Using what you learn during this unit, you will work as part of a team to produce a media project—such as a poster, audio or video public service announcement (PSA), or brochure—about a science-based societal issue related to nuclear chemistry.

Your project will need to explain the relevant chemistry content to your audience. What do you need to know about nuclear chemistry in order to create your project?

> **Note:** During Step 3, you and your team members will each complete Handout 5 independently. All other steps should be completed working as a team.

Step 1: Explore project topics

Make a preliminary choice from Handout 3. (You will have a chance to change your mind later, after you've done a little research about your topic.) Then, come up with a list of questions you will need to answer in order to complete the project. Write each question on a sticky note, and post it in the Question Board.

Step 2: Look at media examples

See how other organizations have gotten their message out about science-based societal issues. Your teacher will show you examples or recommend Web sites to look at.

Step 3: Begin your research and make your final topic selection

Learn more about the topic you have chosen. Be sure to look at different types of sources—this is especially important when studying a controversial issue.

During this research on your topic, you may decide one of the other topics from Handout 3 is more interesting. Or, as you learn about both sides of an issue, you may decide that you disagree with the client's position so strongly you don't want to help them get their message out! This is your chance to change your mind.

Once you and your partner have made a final choice of topic, complete **Handout 5: Research for Your Media Project**. Each of you should complete the handout individually, using difference sources.

Handout 5 due date: _____

NAME DATE

Step 4: Write a statement of purpose

Will your project educate and inform in an unbiased way, or will it advocate for a particular position? Write a statement of purpose—a single sentence that describes what you intend to do. Your statement should include the format of your media project, your audience, and the outcome. For example,

- Our poster (media format) will help patients undergoing radiation therapy (audience) understand how the therapy works. (outcome)

- Our brochure will convince consumers that food irradiation is a good idea and that irradiated foods are safe to eat.
- We will present consumers with balanced information about food irradiation, so they can decide for themselves whether or not to eat irradiated foods.

Statement of purpose due date: _____

Step 5: Finish your research and write a bibliography

What scientific information will you need to accurately and clearly communicate about your topic? You will learn a lot about the science behind your topic in class. But you may need to learn more to complete your project.

You will also need some non-scientific information: You may also want to know

- How does the public feel about the issue?
- What organizations—businesses, nonprofits, government agencies—have a stake in the issue?

Continue your research until you have found all the information you need to achieve the objective expressed by your statement of purpose. Then write a bibliography listing all the sources. The bibliography should include the sources you each used for Handout 4, but it should include additional sources as well.

Bibliography due date: _____

Step 6: Explain the science

Write an explanation of the science related to the topic you have chosen. For example, if your project is about the dangers of nuclear energy, describe

- the decay process for the isotopes used as fuel
- the possible biological effects of radiation from reactor leaks and from nuclear waste

Explain the science thoroughly, even if you don't plan to include that amount of detail in your media project.

Science explanation due date: _____

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Step 7: Do a draft, outline, or mock-up and get feedback

Conduct any additional research needed and keep a record of your sources. Make preliminary decisions about the content of your project. For example, if you are working on an audio PSA, write a rough draft of the script. If your project is a poster, draft the text for the poster and do a sketch of what the poster will look like.

You will either submit the draft to your teacher for feedback, or meet with another team to provide each other feedback.

Draft due date: _____

Step 8: Complete the project and an artists' statement for the team

Create the final version of your media project. In addition, write a short artists' statement describing

- why you chose the topic
- the decisions you made about what position to take, what information to include, and how to present this information

Project and artists' statement due date: _____

Step 9: Share Your Work at the Media Fair

Set up a display of your work for other students to view. Include the following:

- Project
- Bibliography
- Artists' statement
- Statement of purpose

Be prepared to answer questions about the science content and your team's design decisions. View other teams' projects and complete peer assessments of several projects using **Assessment Checklist 2: Media Fair Peer Assessment**.

Date of Media Fair: _____

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Handout 3:
The Power of the Nucleus Project Topics

With any science-based societal issue, there are organizations that try to inform or persuade the public. A variety of different media can be used to do this.

You work for a media production company that specializes in communicating with teens and young adults. You and your partner will produce a piece of media for one of the clients described below.

> **Note:** Unless otherwise noted, your audience is high school and college students and recent graduates. Assume your audience has a basic knowledge of chemistry.

Category 1: Radiation in Everyday Life

Topic 1A: Irradiated foods

Client: A supermarket chain

Food irradiation is the process of exposing food to ionizing radiation. A main purpose of this is to destroy microorganisms, bacteria, viruses, or insects, which helps prevent food-borne illnesses and also reduces spoilage. A supermarket chain wants a brochure or poster about the pros and cons of irradiating food. The brochure or poster must explain why foods are irradiated and what the possible drawbacks are, in a way that helps food shoppers make an informed decision about whether or not to purchase irradiated foods. This explanation should address people's concerns about whether irradiation makes foods radioactive.

Topic 1B: Radon

Client: State department of environmental protection

Radon is a naturally occurring colorless, odorless, radioactive gas that is found in many homes. While many states already have programs in place to inform homebuyers about radon, this client wants to inform young adults who rent housing about radon. They want a public service announcement (PSA) to play on radio stations. The PSA should give an overview of the health hazards of radon, how to test for it, and what to do if you have radon in your home. It should also motivate listeners to visit the department's (hypothetical) Web page for further details.

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Category 2: Nuclear Energy

Topic 2A: Nuclear power plants

Client: A nonprofit environmental group

Nuclear fission releases a lot of energy, and this energy can be used to generate electricity. Facilities that do this are called nuclear power plants. A nonprofit environmental group believes that nuclear power is a key part of any plan to reduce greenhouse gas emissions. The nonprofit wants a script and storyboard for a video public service announcement (PSA) that will convince young voters that nuclear power plants are safe. The PSA should address the environmental and safety concerns about the power plants themselves and about the nuclear waste produced by these plants.

Topic 2B: Cold fusion

Client: A university

Nuclear fusion, a reaction in which two or more nuclei join together, also releases a lot of energy. Fusion typically occurs at very high temperatures, like those found in the sun and other stars. Because such high temperatures are needed, it has not been possible to build nuclear power plants that use nuclear fusion. If scientists could find a way to make fusion occur at low temperatures (called "cold fusion"), nuclear fusion power plants could be built. However, ever since a couple of scientists' claims about achieving cold fusion turned out to be a hoax, the topic of cold fusion has become a joke. But if cold fusion could be achieved, it would solve the world's energy crisis, so there are many organizations that want to pursue research in this area. A university wants to convince potential donors that cold fusion is more than a joke. Create a brochure or Web page explaining what cold fusion is, why it's worth investing in, and how researchers are approaching it.

Category 3: Scientific and Medical Applications

Topic 3A: Radioactive dating

Client: A natural history museum

Radioactive isotopes occur naturally throughout the universe, including Earth. These radioactive isotopes decay over time. By looking at the percentage of a material that is still radioactive, scientists can estimate the age of rocks, fossils, and archeological artifacts. (This technique is called radioactive dating, radiometric dating, or radiochemical dating.) As part of a campaign to educate high school and college-aged visitors about evolution and the age of the Earth, a natural history museum wants a brochure or poster explaining how carbon dating and other types of radioactive dating provide evidence of the Earth's age and of the number of years life has been evolving on Earth.

Topic 3B: Radiation therapy for cancer

Client: A hospital

Radiation therapy is one of the primary ways to treat cancer. In radiation therapy, cancer cells are killed through exposure to radioactive substances. A hospital wants to educate its teen and adult cancer

patients about how radiation therapy works and its pros and cons. Many people are confused by the idea that radiation both causes cancer and can be used to treat cancer, so be sure to address this in your project.

Topic 3C: Nuclear medicine

Client: A hospital

Nuclear medicine is the use of radioactive materials to diagnose disease. In one common type of procedure, a radioactive tracer is swallowed, inhaled, or injected into a vein. The patient is then scanned using a special camera, such as a gamma ray camera or a PET scanner. A hospital wants a poster to display in waiting rooms that explains how the potential benefits are weighed against the health risks when deciding whether a patient should undergo a nuclear medicine procedure.

Category 4: Nuclear Legacy

Topic 4A: Nuclear weapons

Client: A nonprofit environmental organization

A nonprofit environmental organization has decided to launch a campaign advocating that the U.S. begin reducing its stockpiles and arsenals of nuclear weapons. As part of their campaign, they want a computer game or simulation that demonstrates the possible negative consequences of continuing to store these weapons. The game or simulation can focus on any aspect of this issue, such as the biological effects of these weapons or the political maneuvering involved in nuclear proliferation and disarmament. Your task is to develop the concept for the game or simulation: write and/or draw a description of the rules, the player's role, and the outcomes that might result from the player's choices.

Topic 4B: Long-term nuclear waste disposal

Client: A nonprofit arts organization

Radioactive waste is produced when radioactive materials are used in a wide variety of applications. Waste from nuclear reactors is of particular concern. Currently, this waste is stored at the sites where it is produced, often in concrete, steel-lined pools of water. This is only a temporary solution, as these sites will eventually run out of storage space. The United States currently has no long-term storage facility for this waste, and such storage is definitely needed.

The storage facility must safely contain the nuclear waste for a long time: 10,000 years is agreed to be the absolute minimum, but many believe the storage facility must contain the waste for a million years. One major challenge of building such a facility is to create a universal warning system that will be understood by whoever—or whatever—is living on Earth in a million years. Some people think that art, with its ability to communicate across cultures and languages, should be part of this warning system. A nonprofit arts organization is holding a competition for artists, asking them to submit drawings or sculptures that will communicate to beings of the distant future: "Danger. Stay away. Do not dig here. What is buried here gives off a type of energy that can kill." The organization has invited your company to submit an entry in the competition. Your art should incorporate scientific concepts about atoms, radiation, and biological effects of radiation, without using words.

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Invent-Your-Own

You can imagine that for many of the topics above, there are organizations with other points of view. Choose one of these topics, invent a new client, and present a different perspective on the issue. Alternatively, choose one of the client/topic combinations above, but use a different media format. Get your teacher's approval for the client, topic, and media format before proceeding.

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Assessment Checklist 1:
The Power of the Nucleus Project

Use this assessment to help you produce your media project. Make sure to include all the requirements. Your teacher will use this assessment to evaluate your work.

Requirements	Percentage of Total Grade	Comments	
Written Explanation of Science		**Student Comments**	**Teacher Comments**
Explains the relevant chemistry content thoroughly and correctly.	**30%**		
Media Project			
Shows the connection between chemistry and the social, political, environmental, or health issue.	**25%**		
Presents a balanced picture of the issue OR argues persuasively for a particular point of view.	**10%**		
Uses appropriate techniques to be appealing and engaging to the target audience.	**10%**		
Uses voice, tone, language, and style appropriate to the target audience.	**5%**		
Uses proper grammar, punctuation, and sentence and paragraph structure.	**5%**		

NAME DATE

Requirements	Percentage of Total Grade	Comments	
Artists' Statement		**Student Comments**	**Teacher Comments**
Explains the team's choice of topic and the team's decisions about what position to take, what information to include, and how to present this information.	**10%**		
Uses proper grammar, punctuation, and sentence and paragraph structure.	**5%**		
Total	**100%**		

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Handout 4:
Consider the Source

Science is just facts, not opinions, right? So can you believe everything you read in a science book, magazine, newspaper, or Web site?

Not really.

Science-based societal issues can be very controversial. Sometimes there is disagreement about the interpretation of scientific data or the data's reliability. More often, people's differing values and priorities lead them to different points of view even when they are starting with the same science information.

As you conduct research for your media project, you will need to be a critical consumer of information. No matter where you find your sources, on the Internet or on the library shelves, you should consider the same criteria when deciding what to believe.

Authorship and publisher: Is the author qualified to write on the subject? What is his or her connection to the subject? Who published the material? Does it come from an educational institution or the government, or from an individual or private organization?

Currency: When was the material published? For books and printed materials, the copyright date gives some idea of how recent the information is. For Web sites, it may be harder to tell—a date on the site, even on the same page, can be updated without updating the other information.

Perspective: Does the source present a variety of perspectives on the subject? If it presents a single perspective, does that perspective seem well supported by scientific information?

NAME DATE

Handout 5:
Research for Your Media Project

On a separate piece of paper, indicate what project topic you and your partner have chosen, and then answer the questions below using information sources related to this project topic.

News article

Article from a printed newspaper or the Web site of a major printed newspaper

1. Bibliographic information, including title, author, publication date, and publisher or Web address.
2. Currency: When was the article written? Does the information in the article seem like something that would change over time? How could you find out?
3. Perspective: Does the article seem to present a balanced perspective on the issue? What features of the article make it seem balanced? What features make it seem biased?
4. What you know: How does the article relate to things you already know about nuclear chemistry? Is the article consistent with what you know, or does it contradict something you have learned?
5. Your position: How did the article contribute to your understanding and/or beliefs about the topic?

Opinion piece

An editorial, blog post, or other opinion piece, on the Web or in print

1. Bibliographic information, including title, author, publication date, and publisher or Web address.
2. Currency: When was the piece written? Is the author's opinion based on information that might change over time?
3. Perspective: What are the author's beliefs or opinions about the topic? How does the author support these beliefs or opinions?
4. Your position: Did the opinion piece influence your beliefs about the topic? Why or why not?

Information from governmental, educational, or advocacy organizations

Books, Web sites, brochures, and other printed or Web-based materials from state, local, or federal government agencies; nonprofit organizations; trade associations; or universities

1. Bibliographic information, including title, author, publication date, and publisher or Web address.
2. Currency: Can you tell or estimate when the materials were written? Is the information likely to have changed since the creation of the materials?
3. Perspective: Based on the identity of the author and publisher, would you expect the informational materials to present a balanced perspective, or to take a side on an issue? Would you describe the materials as advocacy or informational? What features support your conclusion?
4. Your position: How does the information contribute to your understanding of and beliefs about the topic?

NAME DATE

Science reference book

Printed textbook or other science reference book

1. Bibliographic information, including title, author, publication date, and publisher or Web address.
2. Currency: How recently was the book published? Could the information have changed since the publication date?
3. Your knowledge: How did this source contribute to your understanding of the topic?

NAME DATE

Assessment Checklist 2:
Media Fair Peer Assessment

Use this assessment to evaluate your peers' media projects.

Team member names:

Project topic:

What was one interesting thing that you learned from this media project?

What did the project's creators do well?

How could the project be improved?