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Open-ended response form that describes Mini-Lesson
Topic/Title: Ionizing Radiation
ML: biological effects
Type: Focused, Practical Task, cooperative study; Taught Lesson;
Intent: Introductory, on-going assessment
General Info: Proposed Grade 5-8 _ Estimated Time: two-40 minutes period
Content knowledge:
Students will learn: Uses of radiation: energy, diagnosis and treatment of disease, medical research, industry, agriculture, and science.
Danger of Radiation:

Overexposure to radiation such as gamma and beta may be dangerous.
Gamma radiation can effect every organ and tissue in the human body.
Radiation causes damage by ionizing material in human cells. If there is a heavily ionized path through the cell wall, the cell may rupture. An atom may be ionized by radiation; the cell can mutate into cancer.
Normal background levels of radiation are not high enough to cause humans any observable biological harm.
People who work in areas where the radiation levels are higher than background radiation have an increased risk of getting cancer, and, if pregnant, have a higher risk of birth defects.
Some biological effects of massive exposure include: nausea and vomiting; malaise and fatigue; increased temperature, and blood changes, and death.

Process Skills:

Questioning,
Displaying information by means of graphic illustrations.
Constructing a chart or table
Collaborating

Generalizing
Classifying
Communicating

Instructional Procedure:

Teacher lecture and reading.
Video-watching, note taking, and class discussion.
Extension: divide students into groups to research a chosen topic and create a poster to present to the class. Titles of posters are: Direct Effects on Cells: Damage to DNA from ionization; Indirect Effects on Cells: Decomposition of Water in the Cell; Cellular Sensitivity to Radiation; Organ Sensitivity to Radiation; and Whole-Body Sensitivity to Radiation.
Use the information in *We Live in a Radioactive World* for active learning activities.
Refer to Active Learning Structures for more extension activities.

Resources/Materials

We Live in a Radioactive World, New Jersey Low-Level Radioactive Waste Disposal Faculty Siting Board
The Atom a Closer Look, 4/97, National Geographic: Radiation Benefits.
Nuclear Waste, *The Earth at Risk*, Environmental video series, Schlessinger Video Production.
Other information materials on biological effects: http://www.nrc.gov/NRC/EDUCATOR/06-BIO/part03.html
Internet information (513 Teacher Folder: Risk.VOM.DOC, & RAD &RISK.DOC)

Assessment/Evaluation

Students share feedback about their research and investigations and about their affective experiences
Teachers and students collaborate to evaluate individual, group, and class-wide learning.

Embedded assessments occur within regular instruction. Students are aware that the activity is being used for assessment and are involved in the generation of criteria for judging performance.

Organize the information collected into graphic organizer and poster. Post-unit drawings and writings indicate whether or not students learned some of the information presented and how they came up with scientifically accurate explanations from their research.

Open-ended response form that describes Mini-Lesson
Topic/Title: Ionizing Radiation
ML: Geiger Counter
Type: Focused, Practical Task, Experiment Fair-Testing Activity; Demonstration; Taught Lesson.
Intent: Introductory, Review __: Assessment __.
General Info: Proposed Grade 5-8 _ Estimated Time: 80 minutes _______.
Content knowledge:
Students will learn that:
Geiger Counter, an instrument that detects forms of ionizing radiation

1. Uses

Prospectors use it to find uranium, thorium, and other radioactive elements.
In Science and industry. It is used in studies involving radioactive substances called radioisotopes.

2. Parts

A fine wire stretched along the axis of a cylindrical metal tube. This central wire and the metal wall of the tube serve as electrodes.
An electronic circuit keeps the wire at a positive voltage of about 1,000 volts, thus creating a strong electric field near the wire.
Most Geiger counter tubes contain a readily ionizable gas, such as argon mixed with a trace amount of ethyl alcohol.

3. Functions

Geiger counter tubes have a window of plastic or mica film through which alpha and beta particles can enter.
Radiation that enters the tube collides with a gas atom, causing the atom to become ionized. This process occurs repeatedly, creating a large number of free electrons.
The electrons spread along the wire, where together they create an electric pulse. The pulse is amplified electronically and is counted by a meter or some other type of registered device.
After each pulse, the counter has a recovery period of about 1/10000 sec and, during which the instrument cannot detect radiation.

4. What does it detect?

Geiger counter can detect low-energy radiation because even one ionizing particle produces one pulse on the central wire.
It cannot measure the energy of a particle or ray because particles of different energies generate pulses of the same size.

Hans Geiger, a German physicist, invented the Geiger counter in 1912. He and the German physicists Walther Muller improved its design in 1928.

How to operate a Geiger Counter?

Turn on.
Check the battery. (900 V preset), calibrate; get the right scale to measure. The correct scale to use at first is the highest scale (e. g. X1000) in order for the meter not be saturated from a relatively large radiation source.
Point at the radioactive material. Radiation that enters a Geiger counter tube hits the gas atoms there, causing them to become ionized.
In a Geiger counter the electrons from ALL gas molecules in the probe chamber are counted as one pulse, which initiates the click. The electrons freed by this process spread along the wire, creating one electric pulse, and making the click sound.
Multiple pulses are usually created by separate events (a ray or particle of radiation interacting with the gas in the tube).
These pulses travel along the wire and are amplified and counted by a meter or other devices.
Draw a flowchart to show the functions of a Geiger Counter.
Use a Geiger Counter to detect low-energy radiation, draw a chart to record findings.

Process Skills:

Questioning,
Hypothesizing,
Creating graphic illustrations,
Measuring, Experimenting,
Observing, Classifying
Communicating: inferring and recording data.

Language/Vocabulary

ionizing radiation, electron, neutron, proton, nucleus, radioactive, radioisotope, uranium, thorium, electronic, alpha, beta, rem, millirem

General Sketch or Model S/M/T Concepts/Principles/Content:
Science:
- Geiger counter as a tool to detect forms of ionizing radiation
- Parts, uses and functions of Geiger counter.

Math:
- Measure, calculate, and record background radiation.
- Measurements for low-energy radiation

Technology:
- Detect radiation using Geiger Counter.
- Develop proper lab techniques to ensure safety and avoid contamination.

Resources/Materials:
- Geiger Counter,
- Materials to be detected
- Resource packet, books, and internet information.

Assessment/Evaluation:
- Students sharing feedback about their investigations and about their affective experiences on the uses and operations of a Geiger Counter
- Teachers and students collaborating to evaluate individual, group, and classwide learning.
- Embedded assessments: post-lesson drawing of a Geiger Counter.
- Students' involvement in the generation of criteria for judging performance.
- Teacher-designated checklists that reflect the most important skills, processes, attitudes, and content in the unit.
- Pre- and post-unit drawings and writings indicate whether or not students learned some of the information presented and how they came up with scientifically accurate explanations for their observations.

Open-ended response form that describes Mini-Lesson
Topic/Title: Ionizing Radiation
ML Half-life
Type: Focused, Practical Task, Experiment, Fair-Testing Activity, Demonstration; Taught Lesson
Intent: Introductory, on-going assessment
General Info: Proposed Grade 5-8
Estimated Time: 30 minutes plus discussion time.
Content knowledge:
Students will learn that:

ISOTOPE is one of two or more atoms of the same element that differ in atomic weight.

Some elements, such as aluminum, fluorine, gold, and phosphorus, have only one naturally occurring isotope. All atoms of each of these elements have the same weight.

Half-life is the time it takes for half of the atoms of an element to decay. It is a measure of the speed with which the isotope undergoes radioactive transformation. The half-life of a radioisotope is an unalterable property of the isotope.

Different isotopes are transformed at different rates. Each isotope has its own characteristic transformation rate. Half-lives of radioisotopes range from microseconds to billions of years.

For example:
When the activity of 32P is measured daily over a period of about three months and the percentage of the initial activity is plotted as a function of time, the curve shown in this graph is obtained.
The data show that one-half of the 32P is gone in 14.3 days, half of the remainder in another 14.3 days, half of what is left during the following 14.3 days, and so on.
From the definition of the half-life, it follows that the fraction of a radioisotope remaining after n half-lives is given by the relationship:

(Original quantity of activity: The activity left after n half-lives) = $(1: 0.5^n)$ or $(1:2^{-n})$.

Process Skills:

- Questioning,
- Hypothesizing,
- Measuring,
- Graphing,
- Experimenting,
- Observing,
- Communicating

Language/Vocabulary:
Half-life, decay, radioactive transformation, radioisotope, archaeological, exponential.

General Sketch or Model S/M/T Concepts/Principles/Content
Science:
Isotope and its own characteristic transformation rate.
The time required for any given radioisotope to decrease to one half of the original quantity is half-life.
Math:
Graph the results of head-or-tail toss.
Graph the rate of radioactive decay and compare results in exponential curve.
Use negative exponential to describe decreasing radioactivity
Technology:
Demonstrate rate of radioactive decay using food coloring.

Instructional Sequence:
Students will generate a radioactive decay table for an imaginary element, use their data to plot a decay graph, develop a concept of half-life, and use the graph to "data" several samples.
The following exercise tests student's understanding by having them generate a 14C decay (with a half-life of 5730 years) graph and use it to date an archaeological material.
Resources/Materials:
Half-life information materials: books, videos, Internet.
For each group of four students:

- Six clear plastic cups
- Food coloring
- A pitcher of water,
- Four 2-ounce measuring cups

Procedure:

1. Understand half-life from lecturing or reading.
2. Use food coloring to simulate radioactive isotope.
3. Label each plastic cup as: cup one whole; cup two1/2; cup three1/4; cup four1/8; cup five1/16, and cup six 1/32.
4. To cup one (labeled Whole), add 4 ounce of water and 4 drops of food coloring of your choice.
5. To cup two (labeled 1/2), add half of the solution from cup one and 2 ounce of water.
6. To cup three labeled 1/4, add half of the solution from cup two and 2 ounce of water.
7. Continue to finish cups labeled 1/8, 1/16, and 1/32.
8. Observe and compare the intensity of color of each solution.
9. Write down your conclusion.

Discussion:

Have students figure out about radioactive decay, half-life, isotopes, etc. from the exercise.
Have students gather library and Internet information about radioactive decay and "carbon dating" to share the next day.
Have them think how archaeologists could use radioactive decay to estimate the age of a radioactive object.

Assessment/Evaluation:

Students sharing feedback about their investigations and about their affective experiences;
Teachers and students collaborating to evaluate individual, group, and classwide learning;
Embedded assessments: the radioactive decay experiment and graph constructed;
Students' involvement in generation of criteria for judging performance;
Teacher-designated checklists that reflect the most important skills, processes, attitudes, and content in the unit;
Post-unit drawings and writings indicate whether or not students learned some of the information presented and how they came up with scientifically accurate explanations for their observations.

Identification of Course Content

A. Content Knowledge and Procedural Knowledge

1. Content Knowledge

Students will gain an understanding of:

Structure of an atom, elements, molecules, and compounds;
Radioactivity, radiation, and ionization;
Sources of ionizing radiation;
Contamination vs. radiation;
Non-ionizing electromagnetic radiation;
Ionizing electromagnetic radiation;
Uses of radiation;
Geiger Counter, an instrument that detects forms of ionizing radiation;
Working safely with radiation;
Effects of exposure to radiation;
Hazard and risk of radiation.

2. Procedural Knowledge

Students will gain an understanding of how to . . .

Identify natural background and manufactured sources of radiation;
Perform, observe, describe, and record results of experiments;
Compare and contrast non-ionized and ionized radiation;
Use Geiger counter to detect forms of ionizing radiation;
Learn how radiation is detected using radiation survey meters;
Measure, calculate, and record background radiation, time and radiation exposure, distance and radiation exposure, shielding for radiation, and radioactivity;
Use graphs to display and compare results;
Predict future growth from observations and measurements;
Read to learn more about radiation;
Learn how radiation affects living things;
Communicate results and reflect on experiences through writing, drawing, and discussion;
Analyze and draw conclusions from the results of tests;
Support conclusions with reasons based upon experiences;
Apply previously learned knowledge and skills to new situations to solve a problem;
Read to enhance understanding of chemistry concepts;
Develop proper lab techniques to ensure safety and avoid contamination.

3. Affective Objectives

The student will gain an understanding of how to develop . . .

An interest in studying radiation and contamination;
Sensitivity to the needs of working safely with radiation;
An awareness of the sources of radiation;
Interest in and enthusiasm toward exploring and investigating properties of radioactive materials and effects of exposure to radiation;
The recognition of the importance of guidelines and experimentation;
An awareness of the uses and importance of radiation in our life;
An appreciation of the safe handling of chemicals.

B. Assessment Practices

1. Assessment Techniques, Practices, and Criteria

Assessment and instructional practices should go hand in hand.
Instructional assessment should build on students' past learning experience and lead toward future learning in the classroom. The purposes of assessment should be 1) to provide information that will help improve day-to-day teaching, and 2) to improve performance, not merely to audit it. Active assessments meet these needs by helping teachers and students to determine what they know, what they are able to do, and what they still need to learn. We assess a child's progress in many ways.

a) Pre-Unit Assessment

In a pre-unit assessment, students share what they already know about the topic before it is introduced. It is a demonstration of both process and content. They apply their problem solving skills in an active process. Pre-unit drawings and writings tap into background knowledge and misconceptions and allow the teacher to design appropriate hands-on experiments and guide discussions. It could include a word map of the vocabulary in the unit.

b) Embedded Assessment

Some of the assessment activities are embedded in the class investigations. This includes predictions, discussions, work products, science journals, and drawings. It may also include a reflection or self-evaluation by the students. In an embedded assessment we observe if the students apply previously learned knowledge.

Throughout the unit the K-W-H-L-A chart helps assess what students already know (K) coming into the unit, what (W) they want to find out, how (H) they are going to find out the answers, what they have learned (L), and how they are going to apply (A) the knowledge.

Various journals and lab notes, prepared by students, demonstrate their ideas, thoughts, observations, and reflections on their learning and scientific investigations through the unit. In their writing they could include: 1) At the beginning of the unit, I didn't know... ; I wanted to know... 2) During the lessons I worked on these experiments... I discovered that... 3) I wonder what would happen if... 4) I researched in reference books and the Internet and learned that...5) I helped us learn about science when I......   6) Now I think that science... 7) Things that I still wonder about and want to learn about...

Recording charts modeled by the teacher and/or designed by the students show the sequential order of observations and provide space for illustrations and descriptions of the students' learning of scientific information.

Students share feedback about their investigations and about their affective experiences; teachers and students collaborate to evaluate individual, group, and class-wide learning.

Embedded assessments occur within regular instruction. Students are aware that the activity is being used for assessment and are involved in the generation of criteria for judging performance.

The following is an example of scoring criteria for student work products:
Score: Accuracy of Information; Depth of Assignment; Creativity of Responses

4
3
2
1
0

describe concepts accurately;
understand; few mistakes;
understand; some mistakes confusion of meanings;
incomplete, nonsense ;
elaborate, connective;
thorough treatment;
partial coverage of work;
surface treatment of parts;
unrelated ;
clear, inventive, fully evident;
use of own imagination;
moderate demonstration;
minimal original ideas;
rely on examples to help organize the wealth of observational data collected;
teacher-designed checklists used in class.

To help organize the wealth of observational data collected, teacher-designated checklists are utilized to reflect the most important skills, processes, attitudes, and content in the unit.

Anecdotal records and science conference sheets help the teacher maintain the record of students' performance, willingness, and ability to work collaboratively.

c) Performance Assessment

Performance tasks are activities in which students can demonstrate their knowledge and higher order thinking skills by manipulating equipment and materials and recording their observations and conclusions. These specially designed activities require the students to use the skills and knowledge they have learned in a unit. Each activity is somewhat familiar to what they have been doing in class, but the task is different from any particular module activity. These tasks require the student to synthesize what they have learned throughout the unit. Most of these are scored with a rubric that defines several levels of competence for the task.

d) Post Assessment

Post-unit drawings and writings indicate whether or not students learned some of the information presented and how they came up with scientifically accurate explanations for their observations. Portfolios of students' work samples demonstrate their growth and development over a period of time. By teaching students to assess themselves and by holding individual conferences, teachers can assess each student's understanding and knowledge. Post unit assessments are designed by the teacher to be evaluated. This could include written and performance tasks designed to assess both process and content skills related to the unit of study.

C. **Instructional Methods**

*cooperative learning
*lecture
*learning centers
*demonstration
*investigation/inquiry
*discovery
*modeling (the way scientists work and learn)
*discussion
*laboratory approach
*process learning
*observation
*communication
*measuring

D**. Instructional Resources**

1. Trade Books:

Knapp, Brian, Uranium and Other Radioactive Elements/Danbury, CT; Grolier, 1996
Summary: Systematic and comprehensive coverage of the basic qualities of uranium and other radioactive elements.
Hare, Tony; Nuclear Waste Disposal, 1st U. S. ed., New York: Gloucester, 1991
Summary: Describes how nuclear waste is created and stored and how we safely dispose of this potentially dangerous material.
Galperin, Anne; Nuclear Energy; Chelsea House, New York, 1992
Summary: Discusses nuclear power and how the positive benefits of nuclear energy are balanced against the problem of disposing of radioactive wastes.
Fact Sheet, Environmental Sciences Training Center, Rutgers University.
Understanding Radiation, Grade Four and Five., Teacher's Manual, 1992 Chem-Nuclear Systems, Inc. and North Carolina Low-Level Radioactive Waste Management Authority.

2. Videos

Nuclear Energy/ Nuclear Waste, The Earth at Risk Environmental video series, Schlessinger Video Productions, ISBN 1-879151-47-2
The Atom a Closer Look,4/97 National Geographic: Radiation Benefits