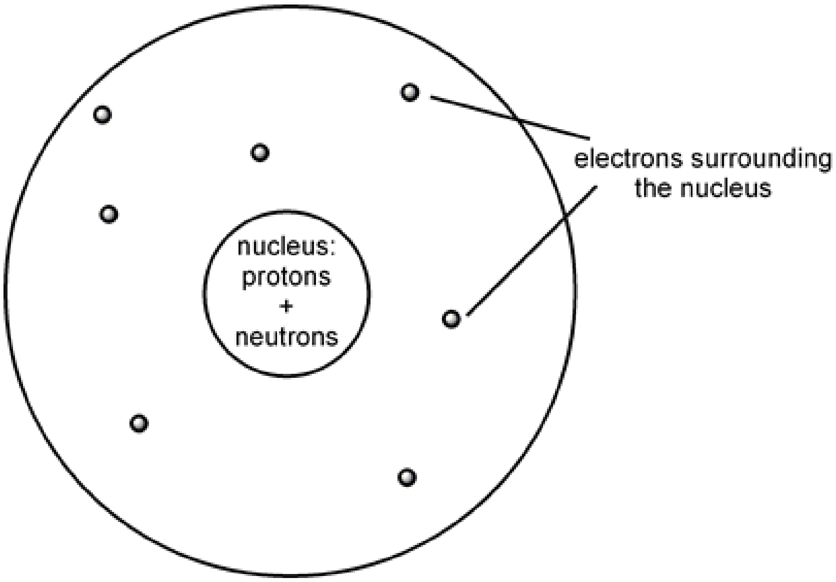
Isotope Rummy
Author(s): Hening Lin & Jane Earle. Modified by Charlene Konkankit & Sierra Marker
Date Created: July 2007. Modified September 2017
Subject: Chemistry
Grade Level: High School
Standards: Next Generation Science Standards (www.nextgenscience.org) **HS-PS1-8** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
Schedule: 60 minutes
CCMR Lending Library Connected Activities: Atomic Bonding

Objectives:	**Vocabulary:**
Students will learn what an isotope is and how their real-world applications make them useful to scientists.	Atomic Number Mass Number Isotope
Students Will: - See the difference between different isotopes of the same element. - Play a game to gain a better understanding of isotopes and their properties.	**Materials:** **For Each Group (4-8 students):** 1 Periodic Table Mat 2 Dice 1 Isotope Rummy Card Set Paper bowls Protons/Neutrons (marbles) Isotope Status Sheets **For Each Student** Activity Sheet **For Teacher** Isotope Rummy Game Rules
Safety	There are no safety concerns for this activity.

Science Content for the Teacher:

The components of an atom.

An atom consists of a nucleus and electrons surrounding the nucleus. The nucleus is made of protons and neutrons. A proton carries one positive charge, an electron carries one negative charge, while a neutron is neutral. A proton and a neutron each have a mass unit of 1, while the mass of an electron can be neglected compared with that of a proton or neutron.



The number of protons in the nucleus determines the identity of the atom. For example, atoms that contain 1 proton in their nucleus are hydrogen atoms, while atoms that contain 6 protons in their nucleus are carbon atoms.
In a neutral atom that carries zero negative charge, the number of electrons surrounding the nucleus is equal to the number of protons in the nucleus. Thus a neutral carbon atom has 6 electrons.

Definition of isotope.

Atoms with the same number of protons in the nucleus can have different numbers of neutrons. Atoms with the same number of protons but different number of neutrons are isotopes of the same element. Typically, the number of protons and neutrons are equal, but this is not always the case. For example, the most common isotope of carbon is ^{12}C, which has six protons and six neutrons. However, ^{238}U is the most common isotope of uranium, which clearly has many more neutrons than protons.

Another difference among isotopes is the mass. Since neutrons have one mass unit, different isotopes of the same element have different masses. This difference, although it cannot change the nature of chemical reactions, could influence the rate of reactions as well as nuclear interactions. For reactions that involve hydrogen atoms, this effect could be significant because the three different hydrogen isotopes have very different masses (the mass of ^{2}H is twice of that of ^{1}H). Biochemists often utilize this effect to study the mechanism of enzymatic reactions.
When speaking of different isotopes, a special kind of notation is used:

$$^{14}_{6}C$$

Here, the superscript number is the mass number, or the total number of neutrons and protons present in the atom. The subscript number is the atomic number, or the number of protons in the nucleus. Other ways to write this same isotope include:

^{14}C	Carbon - 14

Properties and practical uses of isotopes.

Isotopes of the same elements tend to behave the same in chemical reactions, which only involve the electrons surrounding the nucleus. However, there are several differences in isotopes that make them very useful in many applications. Different isotopes can differ dramatically in stability. Some isotopes are very stable, while others are unstable and decay spontaneously which emits radiation (energy). Thus the unstable isotopes are called radioactive isotopes. For example, ^{31}P is a stable isotope of phosphorus, while ^{32}P is a radioactive isotope. Because radioactivity can be easily detected, radioactive isotopes are very useful in labeling and tracing chemical species in biochemistry or medical applications, for example to track the spread of a drug in the body .
The rate at which the radioactive isotope decays is given by its *half-life*, the interval after which half of the material breaks down. Half-life varies between a fraction of a second and thousands of years. ^{14}C, with a half-life of roughly 5700 years, has been used to determine the approximate age of an artifact or fossil. Isotopes with very short half-lives cannot be used for this because after thousand of years, all the radioactive isotope would have been decayed and there would be no difference in samples from different ages.

Radioisotope decay can also be accelerated by supplying external energy, such as neutrons. Because some radioisotopes generate more neutrons when they decay, this could generate a “nuclear chain reaction” and produce massive energy. This is how the most famous isotope ^{235}U, is used in nuclear power plants and weaponry.

Different isotopes sometimes also differ in spin numbers which determine whether they have a signal in nuclear magnetic resonance (NMR). For example, ^{12}C, the most abundant carbon isotope, is NMR silence, while ^{13}C has a NMR signal. The most abundant nitrogen isotope ^{14}N is NMR silence, while ^{15}N has an NMR signal. Thus, ^{13}C and ^{15}N have been routinely used to label chemical species in NMR studies to obtain structural information.

Preparation:

- Prepare printed materials for students (Activity Sheet).

Classroom Procedure:

Engage (Time: 10 mins)

Give students a very brief introduction to isotopes by reviewing the meaning of mass number, atomic number, and chemical notation. Do not give them the definition of an isotope, they will be writing their own later.

Explore (Time: 30 mins)

Have students play Isotope Rummy (refer to games rules sheet). Move about the class and answer questions about isotopes as they arise.

Explain (Time: 20 mins)

Have the students complete the Activity Sheet in their groups from the game. Have students present their answers and discuss them with the class.

Assessment:

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

4= exceeds expectations
3= meets expectations consistently
2= meets expectations occasionally
1= not meeting expectations

	Engage	Explore	Explain
4	Shows leadership in the discussion and a good understanding of isotopes.	Plays game fairly; seeks further understanding of isotopes through information on cards and the game rules.	Provides an in depth explanation of findings. Makes excellent and thoughtful comparisons to everyday life. Fills out worksheet clearly.
3	Participates in the discussion and shows an understanding of isotopes.	Plays game, seeks some further knowledge of isotopes.	Provides clear explanation of findings. Notes good correlations to everyday life. Fills out worksheet clearly.
2	Contributes to the discussion, but shows little understanding of isotopes.	Make some mistakes with the game, seeks some further knowledge of isotopes.	Provides a limited explanation of findings. Struggles to make comparisons to everyday life. Fills out some of the worksheet.
1	Does not participate in discussion. Shows no understanding of isotopes.	Has trouble playing fairly, does not seek to further understand isotopes.	Is not clear in explanation of findings. Does not fill out worksheet.