Information Sheet for Teachers: Chien-Shiung Wu (1912 - 1997)

This information sheet is designed for teachers only.

In March 1944, Chien-Shiung Wu joined the Manhattan Project's Substitute Alloy Materials (SAM) Laboratories at Columbia University. The SAM Laboratories, headed by Harold Urey, supported the Manhattan Project's gaseous diffusion (K-25) programme for uranium enrichment. She helped to develop a process for separating the isotopes U-235 and U-238 by gaseous diffusion. Chien-Shiung Wu worked with James Rainwater and William W. Havens, Jr., to develop radiation detector instrumentation. In September 1944, the Manhattan District Engineer, Colonel Kenneth Nichols contacted Chien-Shiung Wu because the newly commissioned B Reactor, the first practical nuclear reactor, had start up and shutting down problems. John Archibald Wheeler and his colleague Enrico Fermi thought that a fission product, Xe-135, with a half-life of 9.4 hours, was the reason and using work from Chien-Shiung Wu's PhD thesis they were able to confirm this. Chien-Shiung Wu used her work in radioactive uranium separation to build the standard model for producing enriched uranium for atomic bombs at the Oak Ridge, Tennessee facility. She also built innovative Geiger counters that are used to measure ionising radiation. Chien-Shiung Wu distanced herself from the Manhattan Project due to the destructive nature of atomic bombs. She also recommended to the Taiwanese president Chiang Kai-Shek, to never build nuclear weapons.

In the KS5 chemistry national curriculum, students' study ions and isotopes; 'use of mass spectrometry in determining relative atomic mass and relative abundance of isotopes'. This aspect of the curriculum has a direct link to Chien-Shiung Wu's work as she supported the Manhattan Project's gaseous diffusion (K-25) programme for uranium enrichment. She helped develop the process for separating uranium metal into U-235 and U-238 isotopes by gaseous diffusion.

Chien-Shiung Wu's work shows a clear link to the national curriculum and her contributions can be incorporated without difficulty.

Chien-Shiung Wu (1912 - 1997)

Picture credit: Britannica

Chien-Shiung Wu was born in a small town near Shanghai, China. She attended a school founded by her father, who supported education for girls, an uncommon practice at that time. Chien-Shiung Wu studied physics at the National Central University in Nanjing. In 1936, Chien-Shiung Wu went to San Francisco and enrolled at the University of California, Berkeley where she completed her PhD in 1940. Unable to find a research position at a university, Wu became a physics instructor at Princeton University, New Jersey and Smith College, Massachusetts.

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After the war, Chien-Shiung Wu began investigating beta decay at Columbia, which occurs when the nucleus of one element changes into another element. Her investigation led to several significant contributions, including making the first confirmation of Enrico Fermi's theory of beta decay.

In 1956, theoretical physicists Tsung Dao Lee and Chen Ning Yang asked Chien-Shiung Wu to make an experiment to prove their theory that the law of conservation of parity did not hold true during beta decay. The law of parity states that all objects and their mirror images behave the same way, however for right hand and left hand, this is reversed. Wu's experiments, which used radioactive cobalt at near absolute zero temperatures, proved that identical nuclear particles do not always act alike. The 1957 Nobel Prize of Physics was awarded to Lee and Yang, Chien-Shiung Wu was not given any credit.

Wu continued making significant contributions to science throughout her life and won several awards. In 1958, her research helped answer important biological questions about blood and sickle cell anaemia. She was the first woman to serve as president of the American Physical Society. She won the National Medal of Science, the Comstock Prize, and the first honorary doctorate awarded to a woman at Princeton University. In 1978, she won the Wolf Prize in Physics. She also published a book in 1965, Beta Decay, which is still a reference for nuclear physicists.

Reference:

https://en.wikipedia.org/wiki/Chien-Shiung_Wu#World_War_II_and_the_Manhattan_Project
https://www.britannica.com/science/beta-decay
https://www.atomicheritage.org/profile/chien-shiung-wu

Chien Shiung Wu

Believed to be the only Chinese person to have worked on the Manhattan Project

ABOUT

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Picture credit: Britannica

Chien-Shiung Wu used her work in radioactive uranium separation to build the standard model for producing enriched uranium for atomic bombs at the Oak Ridge, Tennessee, facility. She also built innovative Geiger counters that are used to measure ionising radiation. Chien-Shiung Wu distanced herself from the Manhattan Project due to the destructive nature of atomic bombs. She also recommended to the Taiwanese president, Chiang Kai-Shek, to never build nuclear weapons.

Did you know?

In 1978, Chien-Shiung Wu won the Wolf Prize in Physics. She also published *Beta Decay*, in 1965, which is still a standard text for nuclear physicists.

Chien-Shiung Wu was the first woman to serve as president of the American Physical Society. She won the National Medal of Science, the Comstock Prize, and was the first woman to receive an honorary doctorate awarded by Princeton University.

In 1958, Chien-Shiung Wu's research helped answer important biological questions about blood and sickle cell anaemia.

Picture credit: The National Science Foundation

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Queen Mary University of London

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Isotopes Activity (easy)

Define what is meant by the term isotope:

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Complete the following table:

Isotope	Atomic Number	Mass Number	Number of Protons	Number of Neutrons	Number of Electrons
^{11}B					
^{10}B					
^{12}C					
^{13}C					
^{16}O					
^{18}O					
^{235}U					
^{238}U					

Chien- Shiung Wu (1912-1916) was born in a small town near Shanghai, China. She played a role in developing the process for separating the two types of isotopes: ^{235}U and ^{238}U. She was the first woman to serve as President of American Physical Society. She also won the National Medal of Science, the Comstock Prize, and the first honorary doctorate awarded to a woman at Princeton University.

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Isotopes Activity Answers (easy)

Define what is meant by the term isotope:

An isotope is a form of an element, which has the same number of protons but a different number of neutrons. This means that the same element, will have a different mass number.

Complete the following table:

Isotope	Atomic Number	Mass Number	Number of Protons	Number of Neutrons	Number of Electrons
^{11}B	5	11	5	6	5
^{10}B	5	10	5	5	5
^{12}C	6	12	6	6	6
^{13}C	6	13	6	7	6
^{16}O	8	16	8	8	8
^{18}O	8	18	8	10	8
^{235}U	92	235	92	143	92
^{238}U	92	238	92	146	92

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Isotopes Activity (medium/hard)

1. Chlorine has two main isotopes: ^{35}Cl and ^{37}Cl. The abundance of ^{35}Cl is 75.8% and ^{37}Cl has an abundance of 24.2%. Calculate the molar mass (M_r) of chlorine.

2. Magnesium has three main isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg. The abundance of ^{24}Mg is 79%, ^{25}Mg is 10% and ^{26}Mg is 11%. Calculate the relative abundance of magnesium.

3. Lithium has two isotopes: ^{6}Li and ^{7}Li. The abundance of ^{6}Li is 7.6%, ^{7}Li is 92.4%. Calculate the relative abundance of lithium.

4. Boron has two isotopes ^{10}B and ^{11}B. ^{10}B has an abundance of 18.7%. The relative atomic mass of Boron is 10.813. What is the percentage abundance of ^{11}B?

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Isotopes Activity Answer (medium/hard)

1. Chlorine has two main isotopes: ^{35}Cl and ^{37}Cl. The abundance of ^{35}Cl is 75.8% and ^{37}Cl has an abundance of 24.2%. Calculate the molar mass (M_r) of chlorine.

$M_r = (35 \times 0.758) + (37 \times 0.242) = 35.5 \text{ g mol}^{-1}$

2. Magnesium has three main isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg. The abundance of ^{24}Mg is 79.0%, ^{25}Mg is 10.0% and ^{26}Mg is 11.0%. Calculate the molar mass (M_r) of magnesium.

$M_r = (24 \times 0.790) + (25 \times 0.100) + (26 \times 0.110) = 24.3 \text{ g mol}^{-1}$

3. Lithium has two isotopes: ^{6}Li and ^{7}Li. The abundance of ^{6}Li is 7.59%, ^{7}Li is 92.4%. Calculate the relative abundance of lithium.

$M_r = (6 \times 0.076) + (7 \times 0.924) = 6.92 \text{ g mol}^{-1}$

4. Boron has two isotopes ^{10}B and ^{11}B. ^{10}B has an abundance of 18.7%. The molar mass (M_r) of Boron is 10.813 g mol^{-1}. What is the percentage abundance of ^{11}B?

10.813 = (10*0.187) + (11*x)
10.813 – 1.87 = 11 x
Divide 11 from both sides
x = 0.813
x = 81.3%

or simply (100 – 18.7)% = 81.3%!