Marie Curie - My Heroine of Science

by

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Planning

I have chosen Marie Curie as the study for my Heroine of Science.

My aims are:-

- to learn more about her as a person, her background which led her into the world of science, and what motivated her;
- to learn more about her famous discoveries of Polonium and Radium;
- to investigate the impact her discoveries have had on society; and
- to investigate the impact of her discoveries on her own life.

The information I require will be sourced from the internet.

Background

Marie Curie was Born Maria Sklodowska on the 7th of November 1867 in Warsaw, Poland. Growing up she received a general education in a local school. Her father, himself a secondary school teacher, also gave her some science tutoring. As women were not allowed to go to university in Poland at that time, she spent 8 years saving and working towards being able to go to Paris to continue her studies, which she did in 1891.

On moving to Paris Maria took on the French pronunciation of her name, Marie, and was accepted at The Sorbonne University where she studied and achieved her degree in Physics and Mathematical Sciences. Not long after her studies finished she met Pierre Curie, a Professor in the School of Physics and they were married the next year (1895). In 1896 Marie passed her teacher's diploma and went to work in the laboratories within the same school as Pierre. In 1897 their first child was born (Irene).

Pierre and Marie were fascinated by Henri Becquerel's discovery of Uranium rays in 1896 and it was this that would set them on the beginning of a long and hard journey of research and discovery.

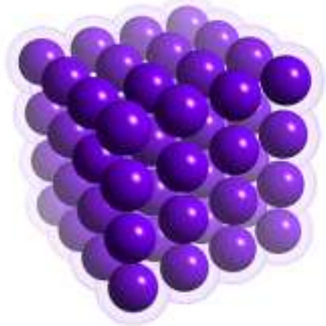
Discoveries

Marie decided to investigate Uranium rays using an electrometer. She discovered that Thorium (see appendix 1) gave off the same rays as Uranium (see appendix 2) and that the strength of the rays did not depend on the compound but on the amount of Uranium or Thorium it contained. Since chemical compounds vary in chemical and physical properties, she concluded that the ability to radiate waves did not depend on the arrangement of the atoms in the molecule, but must be linked to the interior of the atom itself. This was without a doubt her greatest discovery.

She decided to study natural ore that contained Uranium and Thorium. She looked into this and chose Pitchblende (see appendix 3) witch was up to 5 times more active than Uranium.

At this point Pierre decided to give up his other research activities and join his wife in her studies. They discovered that the activity in the Pitchblende came with the fractions containing Bismuth and Barium. She found that when she took away an amount of Bismuth, a residue of a greater activity was left. By June of 1898 they published their work on the metal they had discovered to be 300 times more active than Uranium, using the term Radioactivity for the first time, and wrote:

> “if the existence of this new metal is confirmed we suggest that it should be called polonium”(see appendix 4)



(Polonium molecule)

This was named after Marie’s homeland, Poland.

They continued with their research and by December of that year they informed the Academy of Sciences that they had also came across yet another very active substance that they suggested should be named Radium (see appendix 5). It was now that they would have to produce an amount of these substances, which they could demonstrate, and determine their atomic weight and ideally isolate them. This was when the real hard work and toil would begin. To achieve this they would need tons of Pitchblende and it was not a cheap substance. But a supply was found which was even more active than the Pitchblende that was used in the original research. The Austrian Academy of Science supplied this to them over time and the Principal at Pierre's school solved their need for space by giving them the use of an unused shed. Marie would break down 20kilos of raw material at a time and would spend complete days separating the Pitchblende down in a boiling mass with an iron rod almost the same size as her. This was very slow and physically demanding work. The state of the shed was very basic, with only old pine tables to work on, and it was not weather proof and they were exposed to the elements. With only the window for ventilation Marie was regularly exposed to toxic gases. At this time they were very unaware of the harmful effects of the substances they worked with on a daily basis. While they did their research both of them had to continue with their teaching, but eventually all their hard work was to pay off.

Finally, from several tons of raw material, Marie managed to isolate 1 decigram of almost pure Radium Chloride and determined its atomic weight to be 225. This was what she presented as her doctoral thesis on 25th June 1903. The members of the examination committee described her findings as the greatest scientific contribution ever made in a doctoral thesis.

Recognition

In 1903 Marie and Pierre Curie's work was recognised when they were awarded the Nobel Prize for Physics. The citation read:

> "In recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Bequerel."

The other half of the award was given to Henri Bequerel for his discovery of spontaneous radioactivity. Marie was the first woman ever to win a Nobel Prize. In the same year she also received, jointly with her husband, the Davey Medal of the Royal Society.

In 1906 Marie gave birth to their second child Eve. On April 19th of that same year Pierre Curie was tragically killed when he was run over by a horse drawn carriage. It is believed that the frail state of his bones, due to exposure to radium, was a contributing factor in his death.

Marie would succeed her husband as Head of the Laboratory and was the first woman ever to be appointed to teach at the Sorbonne and in 1908 she was appointed the first woman Professor at the Sorbonne. She continued her research and in 1911 she was awarded a second Nobel Prize, this time in Chemistry. The citation read:-

> "In recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element."

In 1914 Marie helped to found the Radium Institute in Paris. She was the first Director of the Institute which would, after her death, be renamed the Curie Institute in her honour.

In the late 1920s when she toured the USA she was the recipient of some 20 distinctions in the forms of honorary doctorates, medals and membership of academies. She was held in high esteem in scientific circles throughout her life.

Development

When the First World War broke out in 1914 Marie realised the potential benefits of X Rays in locating bullets and determining injuries suffered by soldiers. She also realised the importance of not moving the wounded and so she invented mobile X Ray units and trained 150 female attendants in their use.

(Marie Curie driving one of her mobile X Ray units in World War I)

Marie sustained her enthusiasm for research throughout her life and did much to establish a radioactivity laboratory in her native Warsaw. In 1929 President Hoover of the USA presented her with a $50,000 gift donated by the American Friends of Science to purchase radium for use in that laboratory. Marie was a Member of the Conseil de Physique Solvay from 1911 until her death and from 1922 she was a member of the Committee of Intellectual Cooperation of the League of Nations.

In the present day polonium is used in the production of space satellites, to eliminate static charge in some machinery, it is used in brushes to remove dust from photographic film and also in nuclear research as a source of Alpha particles.

Radium was first used for its luminous properties in the production of self luminous paint which was used on clocks and machine instrument dials. It was believed to be the new wonder product and was used as a preservative in food. It was also used in toothpaste and body and hair creams. Its use for many of these purposes was abandoned, however, when its adverse side effects came to light. In time its potential in the field of medicine was realised and its greatest use is in the treatment of cancer by radiation therapy (see appendix 6).

Marie Curie died on 4th July 1934 of Leukaemia thought to be brought on by the exposure of high levels of radiation.

Conclusions

Marie Curie was an extraordinary woman whose achievements were outstanding. More so because she lived in a time when women were neither expected or encouraged to pursue academic excellence. Her dedication, commitment and passion are an inspiration to scientists all over the world and her achievements are a great example to all women.

Her discoveries have opened the gates for countless forms of scientific advancement, which continue to affect all of our lives today.

I consider, therefore, that she is eminently deserving of admiration and that is why I have chosen her as my “Heroine of Science”.

Evaluation

While researching the discoveries made by Marie Curie I did not come across any scientific argument disputing their existence or there atomic structure, this made validating the scientific evidence easy.

The awards and accolades received by her are well documented.

However, accounts of the personal challenges she overcame and her strong characteristics can only be based largely on opinion and are therefore almost impossible to validate.

If I were to approach this project again I would investigate a “Historic Scientific Discovery”, rather than “My Heroine of Science” as the latter title involves too much personal opinion to be validated.

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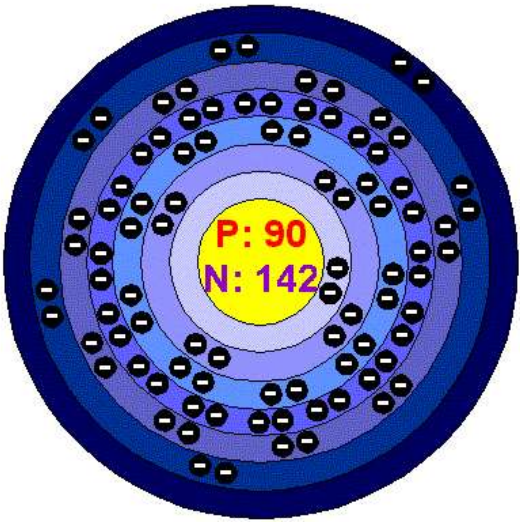
Appendix 1

Thorium

Symbol: Th
Atomic Number: 90
Atomic Mass: 232.0381 amu
Melting Point: 1750.0 °C (2023.15 K, 3182.0 °F)
Boiling Point: 4790.0 °C (5063.15 K, 8654.0 °F)
Number of Protons/Electrons: 90
Number of Neutrons: 142
Classification: Rare Earth
Crystal Structure: Cubic
Density @ 293 K: 11.72 g/cm^3
Color: silvery



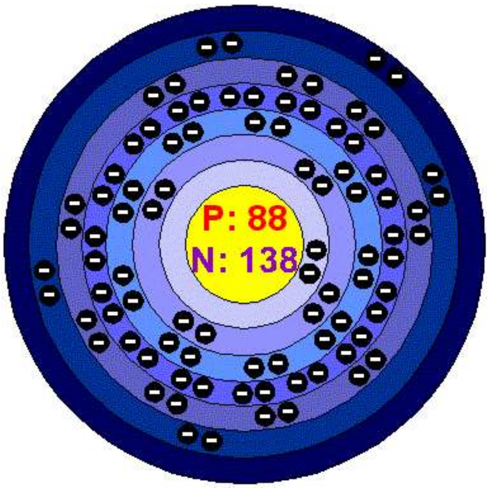
Isotopes

Isotope	Half Life
Th-226	30.6 minutes
Th-227	18.72 days
Th-228	1.91 years
Th-229	7340.0 years
Th-230	75400.0 years
Th-231	1.06 days
Th-232	1.4E10 years
Th-233	22.3 minutes
Th-234	24.1 days

Appendix 2

Uranium

Symbol: U
Atomic Number: 92
Atomic Mass: 238.0289 amu
Melting Point: 1132.0 °C (1405.15 K, 2069.6 °F)
Boiling Point: 3818.0 °C (4091.15 K, 6904.4 °F)
Number of Protons/Electrons: 92
Number of Neutrons: 146
Classification: Rare Earth
Crystal Structure: Orthorhombic
Density @ 293 K: 18.95 g/cm^3
Color: silverish



Isotopes

Isotope	Half Life
U-230	20.8 days
U-231	4.2 days
U-232	70.0 years
U-233	159000.0 years
U-234	247000.0 years
U-235	7.0004E8 years
U-236	2.34E7 years
U-237	6.75 days
U-238	4.47E9 years
U-239	23.5 minutes
U-240	14.1 hours

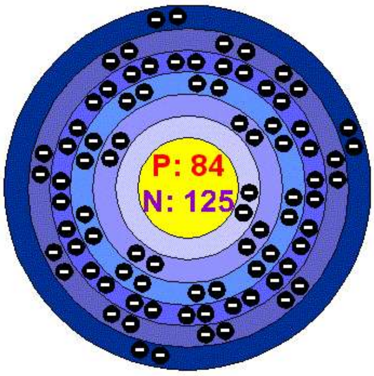
Appendix 3

Uraninite is a uranium-rich mineral with a composition that is largely UO_2 (uranium dioxide), but which also contains UO_3 and oxides of lead, thorium, and rare earths. It is most commonly known in the variety **pitchblende** (from *pitch*, because of its black color, and *blende*, a term used by German miners to denote minerals whose density suggested metal content, but whose exploitation was, at the time they were named, either impossible or not economically feasible). All uraninite minerals contain a small amount of radium as a radioactive decay product of uranium; it was in pitchblende from the Jáchymov (then Joachimsthal, Austria-Hungary) now in the Czech Republic that Marie Curie discovered radium. Uraninite also always contains small amounts of the lead isotopes, Pb-206 and Pb-207, the end products of the decay series of the uranium isotopes U-238 and U-235 respectively. Small amounts of helium are also present in uraninite as a result of alpha decay. Helium was first found on Earth in uraninite after previously being discovered spectroscopically in the Sun's atmosphere. The extremely rare element technetium can be found in uraninite in very small quantities (about 0.2 ng/kg), produced by the spontaneous fission of uranium-238.

Uraninite is a major ore of uranium. An important occurrence of pitchblende is at Great Bear Lake in the Northwest Territories of Canada, where it is found in large quantities associated with silver. Some of the highest grade uranium ores in the world have been found in the Athabasca Basin in northern Saskatchewan. It also occurs in Australia, Germany, England, and South Africa. In the United States it can be found in the states of New Hampshire, Connecticut, North Carolina, Wyoming, Colorado and New Mexico.

Appendix 4

Name: Polonium
Symbol: Po
Atomic Number: 84
Atomic Mass: (209.0) amu
Melting Point: 254.0 °C (527.15 K, 489.2 °F)
Boiling Point: 962.0 °C (1235.15 K, 1763.6 °F)
Number of Protons/Electrons: 84
Number of Neutrons: 125
Classification: Metalloid
Crystal Structure: Monoclinic
Density @ 293 K: 9.4 g/cm^3
Color: Unknown



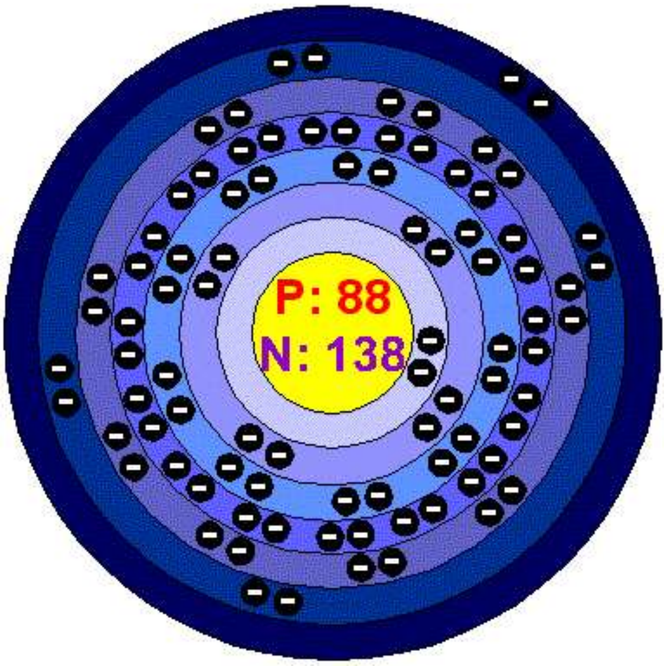
Isotopes

Isotope	Half Life
Po-206	8.8 days
Po-207	5.8 hours
Po-208	2.89 years
Po-209	102.0 years
Po-210	138.38 days
Po-211	0.51 seconds
Po-212	0.29 microseconds
Po-213	4.0 microseconds
Po-214	163.7 microseconds
Po-215	1.78 milliseconds
Po-216	0.14 seconds
Po-218	3.1 minutes

Appendix 5

Radium

Symbol: Ra
Atomic Number: 88
Atomic Mass: (226.0) amu
Melting Point: 700.0 °C (973.15 K, 1292.0 °F)
Boiling Point: 1737.0 °C (2010.15 K, 3158.6 °F)
Number of Protons/Electrons: 88
Number of Neutrons: 138
Classification: Alkaline Earth
Crystal Structure: Cubic
Density @ 293 K: 5.0 g/cm^3
Color: silverish



Isotopes

Isotope	Half Life
Ra-222	38.0 seconds
Ra-223	11.43 days
Ra-224	3.66 days
Ra-225	14.9 days
Ra-226	1600.0 years

Appendix 6

Radiation therapy

Definition

Radiation therapy uses high powered x-rays or radioactive seeds to kill cancer cells.

Alternative Names

Therapy - radiation; Radiotherapy

Information

Cancer cells usually multiply faster than other cells in the body. Because radiation is most harmful to rapidly growing cells, radiation therapy damages cancer cells more than normal cells. Specifically, radiation therapy damages the DNA of cancer cells. Doing so prevents the cancer cells from growing and dividing. Unfortunately, certain healthy cells can also be killed by this process. The death of healthy cells can lead to side effects.

Radiation therapy is used to fight many types of cancer. It is often used to shrink a tumor as much as possible before surgery. Radiation can also be given after surgery to prevent the cancer from coming back.

For certain types of cancer, radiation is the only treatment needed. Radiation treatment may also be used to provide temporary relief of symptoms, or to treat malignancies (cancers) that cannot be removed with surgery.

There are two forms of radiation therapy:

- External beam radiation is the most common form. This method carefully aims high powered x-rays directly at the tumor from outside of the body.
- Internal beam radiation uses radioactive seeds that are placed directly into or near the tumor. Internal beam radiation is also called interstitial radiation or brachytherapy.