

# K08 Chemistry Elements Group 3 Part I Actinium



English with  
2 Little Pigs



[www.with2littlepigs.com](http://www.with2littlepigs.com)



Mozart - Piano Concerto No.20 (1785)

Name the Lanthanide Elements of the  
Transition Metals



# Periodic Table of the Elements

1 <b>H</b> Hydrogen 1.008																	2 <b>He</b> Helium 4.003
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012											5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305											13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798
37 <b>Rb</b> Rubidium 85.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.904	54 <b>Xe</b> Xenon 131.293
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [208.982]	85 <b>At</b> Astatine 209.987	86 <b>Rn</b> Radon 222.018
87 <b>Fr</b> Francium 223.020	88 <b>Ra</b> Radium 226.025	89-103	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [278]	110 <b>Ds</b> Darmstadtium [281]	111 <b>Rg</b> Roentgenium [280]	112 <b>Cn</b> Copernicium [285]	113 <b>Nh</b> Nihonium [286]	114 <b>Fl</b> Flerovium [289]	115 <b>Mc</b> Moscovium [289]	116 <b>Lv</b> Livermorium [293]	117 <b>Ts</b> Tennessine [294]	118 <b>Og</b> Oganesson [294]

Lanthanide Series

57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.243	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
---	--------------------------------------	--	---	--	---------------------------------------	--	---	---------------------------------------	--	---------------------------------------	--------------------------------------	---------------------------------------	---	--

Actinide Series

89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---

Alkali Metal

Alkaline Earth

Transition Metal

Basic Metal

Metalloid

Nonmetal

Halogen

Noble Gas

Lanthanide

Actinide

© 2019 IUPAC Commission on Nomenclature of Inorganic Chemistry  
www.iupac-nomenclature.org  
www.chemical-elements.org

# Actinides

Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
-----------------	--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---

- |                      |                      |                       |
|----------------------|----------------------|-----------------------|
| 1. Actinium (89)     | 6. Plutonium (94)    | 11. Einsteinium (99)  |
| 2. Thorium (90)      | 7. Americium (95)    | 12. Fermium (100)     |
| 3. Protactinium (91) | 8. Curium (96)       | 13. Mendelevium (101) |
| 4. Uranium (92)      | 9. Berkelium (97)    | 14. Nobelium (102)    |
| 5. Neptunium (93)    | 10. Californium (98) | 15. Lawrencium (103)  |

There are 15 Actinides.

Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]
-----------------	------------------------------	-----------------------------	----------------------------------	----------------------------	-------------------------------	-------------------------------	-------------------------------	----------------------------	-------------------------------	---------------------------------	-------------------------------	------------------------------	--------------------------------	-------------------------------	-------------------------------

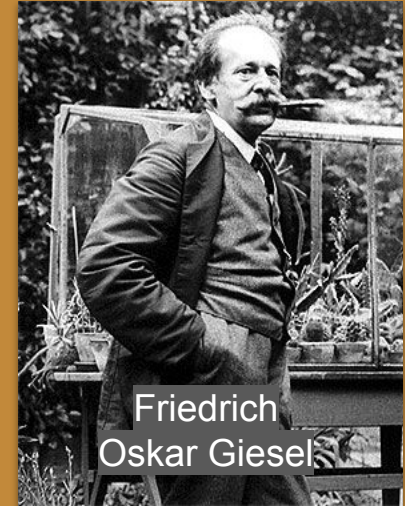
# Actinium



Actinium was first isolated from Pitchblende (Radioactive uranium-rich mineral) by German Chemist, Friedrich Oskar Giesel, in 1902, he gave it the name *emanium* and was wrongly identified with a substance André-Louis Debierne found in 1899, called actinium.

Actinium gave the name to the actinide series, a set of 15 elements between actinium and lawrencium in the periodic table. Together with polonium, radium, and radon, actinium was one of the first radioactive elements to be isolated and commonly known as “heavy metals”.

89	Ac
----	----



Friedrich  
Oskar Giesel



Pitchblende

Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
-----------------	--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---



# Thorium



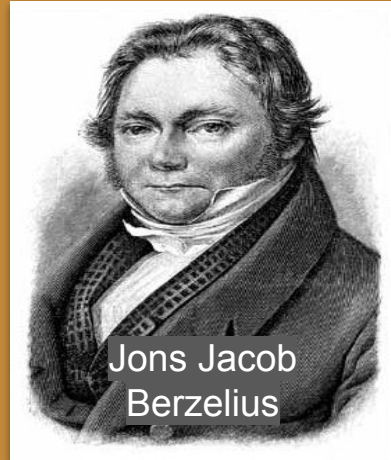
Thorium was discovered in 1828 by the Norwegian amateur mineralogist Morten Thrane Esmark in the mineral now called “thorite” and identified by the Swedish chemist Jöns Jacob Berzelius, who named it after Thor, the Norse god of thunder.

Its first applications were developed in the late 19th century. Thorium's radioactivity was widely acknowledged during the first decades of the 20th century.

In the second half of the century, thorium was replaced in many uses due to concerns about its radioactivity.

90

Th



Jöns Jacob  
Berzelius

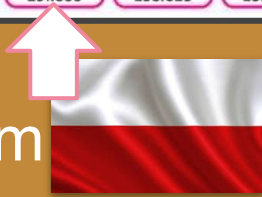


Thorite



Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
-----------------	--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---

# Protactinium



The element was first identified in 1913 by Polish Kazimierz Fajans and his German student, Oswald Helmut Göhring. They named it "brevium" because of the short half-life of the specific isotope being studied (today called protactinium-234).

A more stable isotope (protactinium-231) was discovered in 1917/18 by German Lise Meitner in collaboration with Otto Hahn, and they chose the name protactinium. The name "protactinium" was confirmed in 1949 with Hahn and Meitner as the discoverers. The new name meant "(nuclear) precursor of actinium" and implied that actinium is a product of radioactive decay of protactinium.

91 Pa



Kazimierz Fajans



Hahn & Meitner



Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
-----------------	--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---

# Uranium

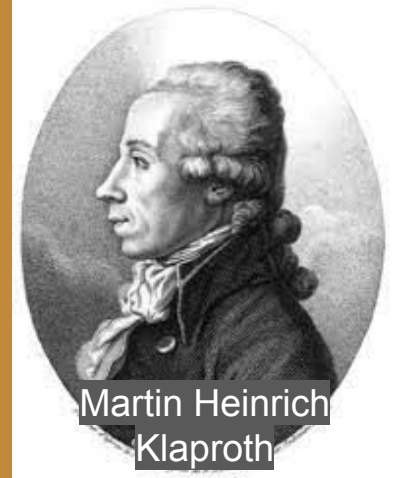


The 1789 discovery of Uranium, in the mineral “pitchblende”, is credited to German Chemist, Martin Heinrich Klaproth, who named the element after the recently discovered Uranus.

Uranium-235 was the first isotope that was found to be fissile, which means it is able to undergo nuclear fission. On being hit with slow neutrons, its uranium-235 isotope will most of the time divide into two smaller nuclei, releasing nuclear binding energy and more neutrons. If too many of these neutrons are absorbed by other uranium-235 nuclei, a nuclear chain reaction occurs that results in a burst of heat or (in special circumstances) an explosion.

92

U



Martin Heinrich  
Klaproth



Pitchblende

# Nuclear Fission

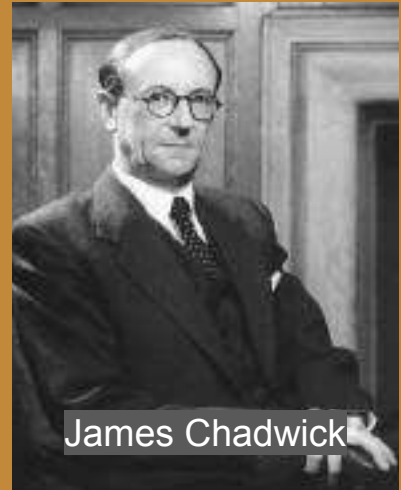
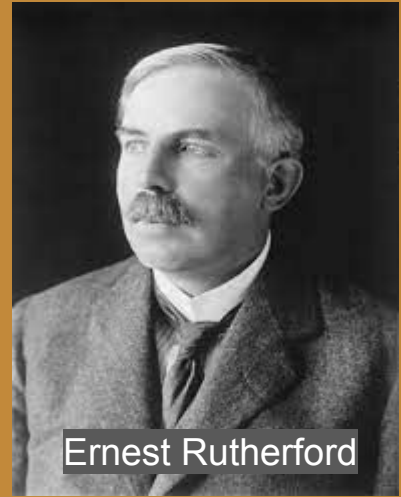
# Discovery of the Neutron

In the 1911 Rutherford model, the atom consisted of a small positively charged massive nucleus surrounded by a much larger cloud of negatively charged electrons.

In 1920, Ernest Rutherford suggested that the nucleus consisted of positive protons and neutrally charged particles.

Both Rutherford and Chadwick were working physicists at the Cavendish Laboratory at Cambridge University.

Chadwick decided to run some experiments in February 1932 and discovered that the radiation he was detecting had the same mass as a proton but with no charge. He had discovered the neutron. He was awarded the Nobel prize in 1935 for his valuable contribution to science.

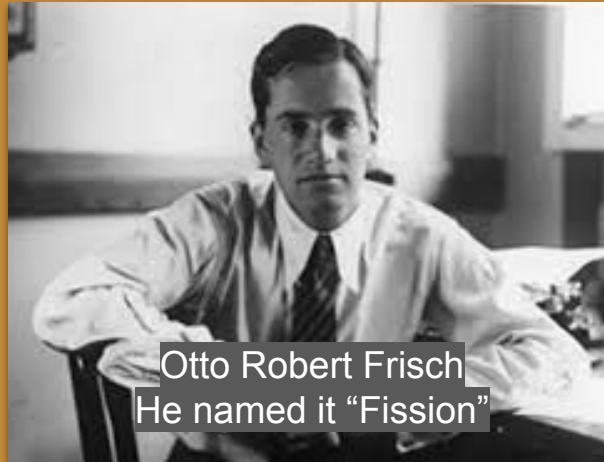




# Discovery of Nuclear Fission

Nuclear fission was discovered on 19 December 1938 in Berlin by German chemists Otto Hahn and Fritz Strassmann.

Physicists Lise Meitner and her nephew Otto Robert Frisch explained it theoretically in January 1939. The process was named "fission" by analogy with biological fission of living cells, by the young Otto Robert Frisch.



# Tube Alloys

Otto Robert Frisch with Rudolf Peierls, at the University of Birmingham UK, co-wrote a memorandum explaining that a small mass of pure uranium-235 could be used to produce a chain reaction in a bomb with the power of thousands of tons of TNT.

Marcus Oliphant, an Australian physicist working in Britain created the MAUD Committee and the creation of an atomic bomb to help win the war.

This led to “Tube Alloys”, the UK research and development programme, with help from Canada. Wallace Akers, who oversaw the project, chose the deliberately misleading code name “Tube Alloys”.



# The Quebec Agreement

Britain initiated the first research project to design an atomic bomb in 1941. The Tube Alloys programme in Britain and Canada was the first nuclear weapons project.

Due to the fact that Britain was fighting a war within bombing range of its enemies they convinced the United States to recognise the importance of this type of research and initiated the Quebec Agreement, under which the three nations agreed to share nuclear weapons technology.

This led to the Manhattan Project and the development of nuclear weapons with Britain supplying the expertise and technology all the way through to completion in 1945.







The Quebec Agreement

# The Manhattan Project

The Manhattan Project was a joint enterprise conducted by the United States and the United Kingdom with support from Canada.

From 1942 to 1946, the project was under the direction of Major General Leslie Groves of the U.S. Army Corps of Engineers who oversaw the construction of the Los Alamos Laboratory in New Mexico where the scientists designed and built the first atomic bomb.

J. Robert Oppenheimer was appointed director and claimed that he got the name for the first test, Trinity, from an obscure English poem that he said he loved. Trinity also happens to be the name of Trinity college, Cambridge, where many of the scientists came from.





Trinity Test



# Hiroshima 1945

Towards the end of World War 2, on August 6th 1945, a B29 bomber, named Enola Gay, dropped an atomic bomb with a uranium core, called “Little Boy”, on the city of Hiroshima in Japan.

The subsequent explosion instantly destroyed the city and killed around 100,000 people. Japan surrendered 4 weeks later ,after 8 years of war, that they had begun with their invasion of China in 1937.



## Atomic Dome



## Memorial



## Little Boy





Little Boy - Uranium Core Atomic Bomb - Hiroshima



The Enola Gay Pilot

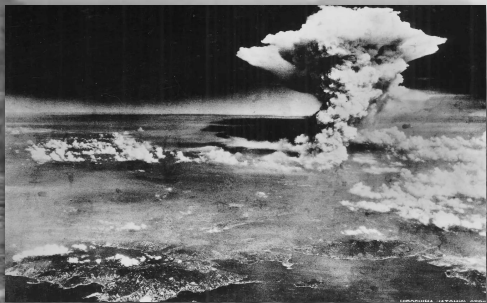


# Actinides

Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]
-----------------	--	---------------------------------------	--	--------------------------------------	---	---	---	--------------------------------------	---	---	---	--	--	---	---

- |                      |                      |                       |
|----------------------|----------------------|-----------------------|
| 1. Actinium (89)     | 6. Plutonium (94)    | 11. Einsteinium (99)  |
| 2. Thorium (90)      | 7. Americium (95)    | 12. Fermium (100)     |
| 3. Protactinium (91) | 8. Curium (96)       | 13. Mendelevium (101) |
| 4. Uranium (92)      | 9. Berkelium (97)    | 14. Nobelium (102)    |
| 5. Neptunium (93)    | 10. Californium (98) | 15. Lawrencium (103)  |

There are 15 Actinides.



The End

