The Noble Gases

Helium, Neon, Argon, Krypton, Xenon, and Radon

By Ananth Ramaswamy

Foreword

Hi! I am Ananth Ramaswamy, and I am 10 years old. I have written this book for kids who are curious about chemistry and want to learn more about it.
My favorite element is Arsenic (As), which, however, is not in this book. This book is about the noble gases, and until recently, I did not know much about them. Researching and writing this book taught me a great deal about these elements.
I plan to be an ornithologist when I grow up, and chemistry is one of my interests. I am fascinated by the chemistry of the composition of the world around me. I would like to thank: Wikipedia Articles on each of these elements, the Amazing Theodore Gray's Elements book, and www.periodictable.com for giving me amazing images of the gas bottles. En.wikipedia.org also gave me good images, especially of the discharge tubes and the discharge tube signs showing the chemical symbol of each element. I had fun writing this book. I hope you have fun reading this book.

Ananth Ramaswamy

Table of Contents

Neon gas discharge tubes (arranged to spell out the atomic symbol for Neon, Ne)

Introducing the Noble Gases

The Noble Gases are six elements that mark the end of the periodic table. They form the 18th group of the periodic table. The noble gases are right next to the halogens in the periodic table. In order (going from up to down) they are: Helium, Neon, Argon, Krypton, Xenon, and Radon. Some scientists consider the highly radioactive element Uuo (Ununoctium) to be a noble gas, but it appears to be distinct from the noble gases, as it is a solid.

Helium discharge (gas-filled) tubes lined up together to produce an image of He, the chemical symbol of Helium.

Many noble gases, such as helium and neon, are very important to our everyday lives. Helium, for instance, is used in balloons and airships, and neon is used in neon signs outside shops in big cities.

Naturally, all noble gases are colorless, but when put in a discharge tube, they will emit a special light. A discharge tube is a tube where if you put any noble gas in it, the electrons in the element get excited and each one shows their own special color. All noble gas discharge tubes emit their own special color. Helium emits a light orange, neon a reddish-orange, argon a purple-pink, krypton a pale pink, and xenon a blue color.

Most noble gases do not react; however, argon will react with fluorine and hydrogen to form argon fluorohydride. Also, xenon forms various compounds with hydrogen and oxygen.

Uses of the noble gases

These are discharge tubes containing five of the six noble gases. They are arranged by atomic mass from lightest to heaviest.

Helium discharge tube sign. Helium has many uses, as it is found in balloons and airships.

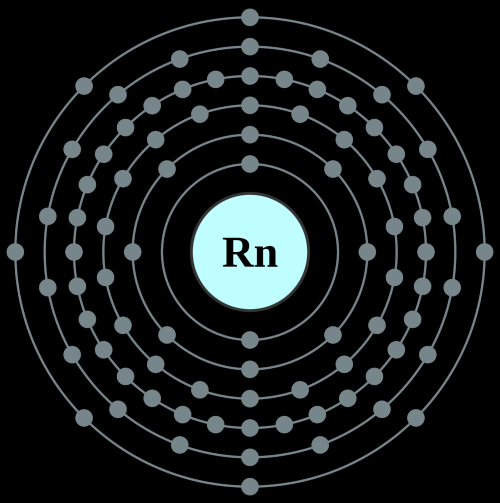
Neon discharge tube sign. Neon is used in store and shop signs. It's natural color is reddish-orange.

Argon discharge tube sign. Argon and other noble gases are added as a substitute for hydrogen in light bulbs.

Krypton discharge tube sign. Krypton, along with argon, is used to help fluorescent light bulbs. Radioactive isotopes are used in wars.

Xenon discharge tube sign. Xenon is used in camera flashes.

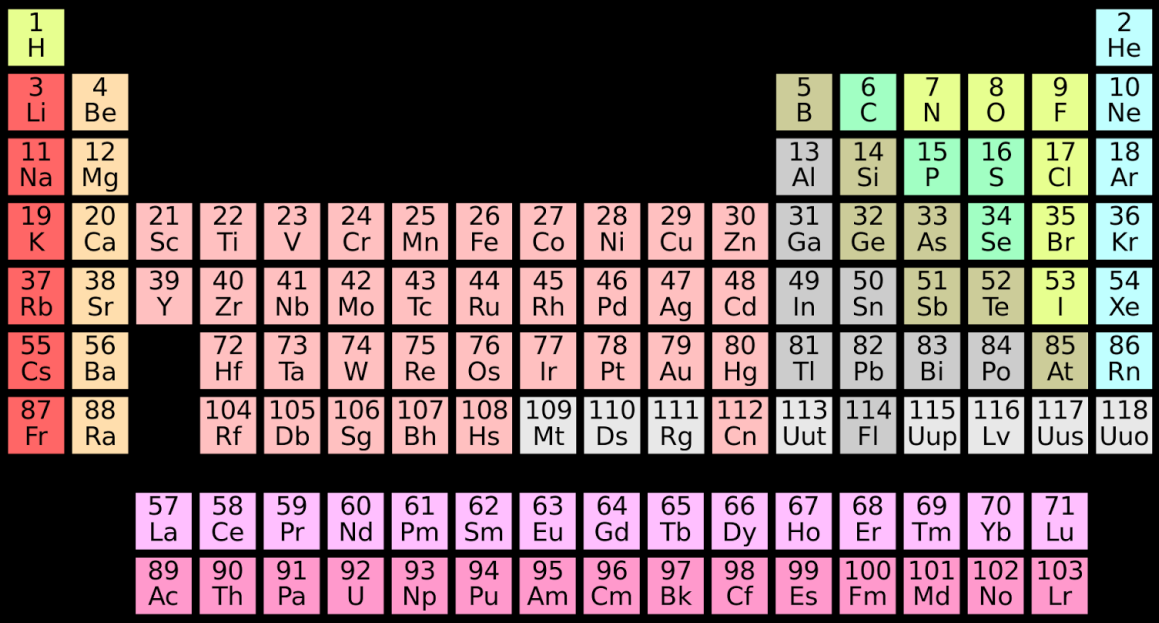
The heaviest noble gas is radon. This element is very radioactive and glows green. It does not have it's own discharge tube.



Radon's electron shells. It is the heaviest of all the noble gases.

Radon is very dangerous to people. Radon poisoning is a common problem in many houses.

Where noble gases are located in the periodic table

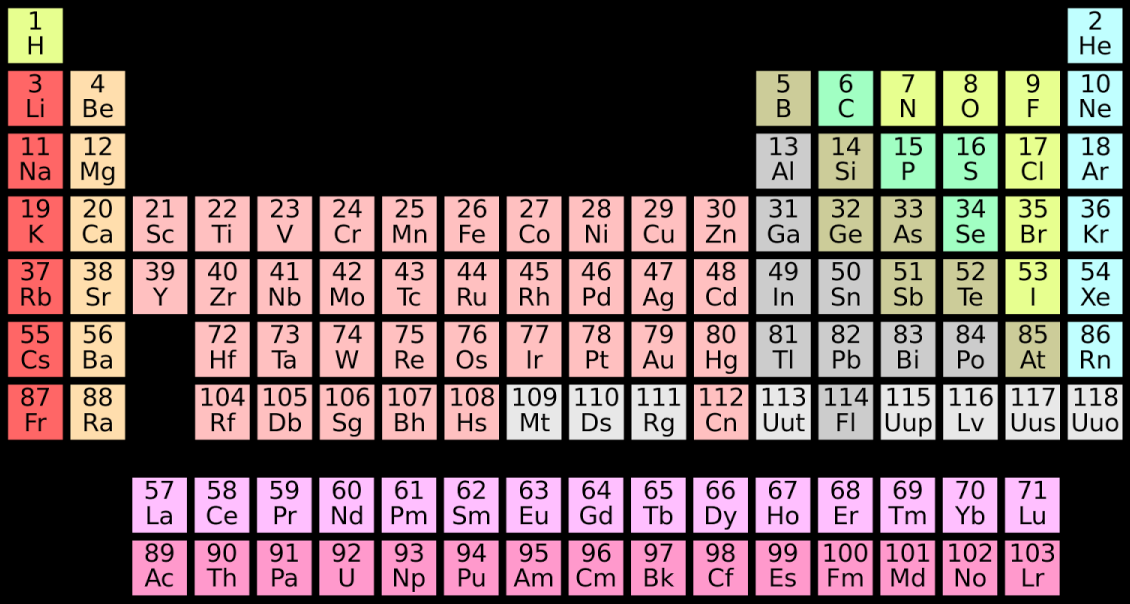


At the end of the periodic table, the blue elements are the noble gases. This periodic table only shows chemical symbols, so He is Helium, Ne is Neon, Ar is Argon, Kr is Krypton, Xe is Xenon, and Rn is Radon.

The noble gases are right next to the halogens (salt formers, e.g Fluorine, Chlorine, etc.), radically different elements, although some are gases.

Helium

Helium is the lightest noble gas. It has many uses, as it can be used to fill up balloons and airships even though it is denser than air, and it can be frozen into a liquid at cryogenic temperatures.



Helium is a noble gas (shown blue on this table). It heads the noble gases, being found right above Neon.

Helium can be fitted into a spectrum discharge tube. These tubes can have noble gases in them and emit a special bright color unique to the element.
Helium has a bright orange color when it is put in a discharge tube.

Helium has an atomic mass of 4.002602. This means that it is much heavier than the lightest element, hydrogen, which has an atomic mass of 1.00794.
This is why people kept filling airships with hydrogen, because it is so light. However, after the Hindenburg disaster in 1937, where the ship caught on fire and exploded, people realized the dangers of hydrogen.

Then people started using the next heaviest element, helium. Since helium is a noble gas and most noble gases are chemically inert, people had hopes for helium. And helium did work, so they started filling airships and balloons with helium rather than hydrogen. Although flight will not be as good as when the airships were filled with hydrogen, it will be much safer.

Spectrum discharge tubes of helium. As shown on page 3, helium is a light element that is safe and not flammable like hydrogen.

Below: Multicolored balloons filled wIth helium. Helium is used in balloons these days because it is safe to handle.

Helium has a very simple outer shell. It has only one shell with 2 electrons in that shell spinning around the helium nucleus.

Fun Fact:
If you inhale helium from a balloon, it will deprive your body of oxygen.

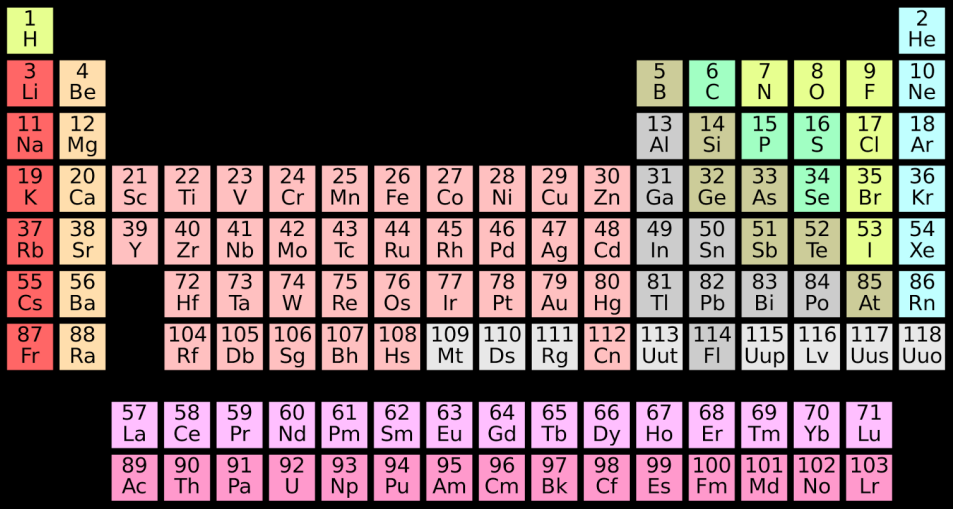
Helium on Earth was discovered by Sir William Ramsay on March 26, 1895. The first observation of helium was on August 18, 1868 in Guntur, India. At first scientists assumed that it was sodium, and called it the D_3 line, because it was near where the D_2 and D_1 lines were discovered.
Then they discovered it was caused by a element unknown in the sun. This would make sense because helium is part of the sun's atmosphere (the heliosphere).
So they named the new element after helios, the greek word for the sun.

Neon

The next lightest noble gas, neon is very different from helium. Helium has only 2 protons, while neon has 10. It has an electron configuration of {He} $2s^2$ $2p^6$.

Neon gas-tube (discharge) sign. Neon is being used in store signs, although LED signs are much safer and are becoming more common.

Neon was discovered by Sir William Ramsay, as he is the person who discovered all of the noble gases (except radon).



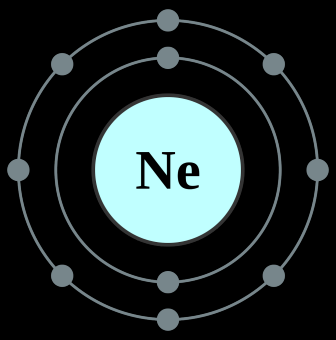
Neon in the periodic table. It is a blue element (noble gas). Neon is next to the halogen fluorine (F), above the noble gas Argon (Ar), and below the noble gas Helium (He).

Neon is a very unique element. It has uses like helium, both gaseous and liquid. The use of gaseous neon for colorful neon signs started with a man named Georges Claude. He tried making neon lights with nitrogen. However, people refused it because of its color. Then Claude decided to make neon signs. Because of the color, he thought, people would be attracted to the bright signs. So in 1912 he introduced neon signs and it worked, as people started coming to shops with neon signs on them.

Liquid neon also has uses. It is multicolored and comes in many forms. It is formed when gaseous neon is put at cryogenic temperatures.
Although not as useful as liquid helium, liquid neon is used as a refrigerant (something put in a refrigerator).


Neon gas bottles. This bottle shows the neon, glowing reddish-orange.

Neon has an atomic number of 10. That means that it's inner shell has 2 electrons, while it's outer shell has 8 electrons.



Neon's electrons. Neon has 2 electrons in the inner shell and 8 electrons in the outer shell.

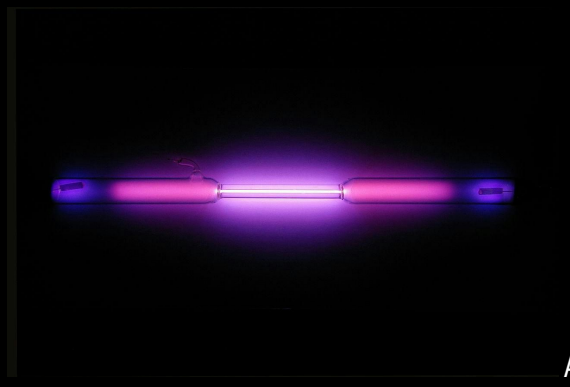
Neon is the second-lightest of it's group, apart from Helium. The third-lightest is Argon, and that element will be in the next chapter.

Argon

Argon is the third-lightest of the noble gases. It is also the third-heaviest.

Argon discharge tube sign. Argon emits a turquoise color in this discharge tube.

Argon has many uses. Because it is largely safe and non-toxic, argon is used in light bulbs, along with neon, krypton, and xenon instead of oxygen, because



Argon discharge (gas-filled tube.) This one emits a different color from the Argon sign, as it is emitting a purple-pink.

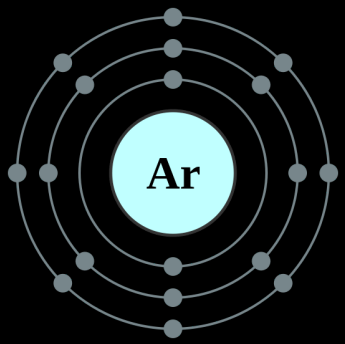
it reacts with the tungsten filament of most light bulbs. A small fraction (0.09%) of our atmosphere is comprised of noble gases (such as Argon).

Argon in the periodic table

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

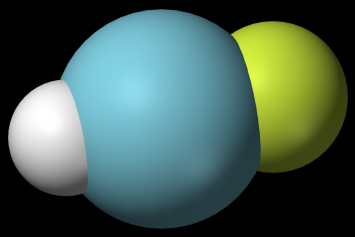
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Argon is the third noble gas. In the periodic table, it is right next to the halogen Chlorine (Cl), above the noble gas Krypton (Kr), and below the noble gas Neon (Ne).



Argon's electron shells. Argon has 2 electrons in the inner shell, 8 in the middle shell, and 8 in the the outer shell. It's atomic number is 18.

A typical fluorescent light bulb. Bulbs like these contain noble gases, including Argon.



Argon fluorohydride, a compound of Argon. Scientists have tried combing argon with fluorine, the most electronegative (and reactive) element, and have failed. Only recently have scientists reacted the two with hydrogen and the results are successful.

Argon in the periodic table. This is a gas-filled discharge tube image.

In the periodic table, the halogen fluorine is extremely reactive. It will react with any element, even if it is chemically considered inert.

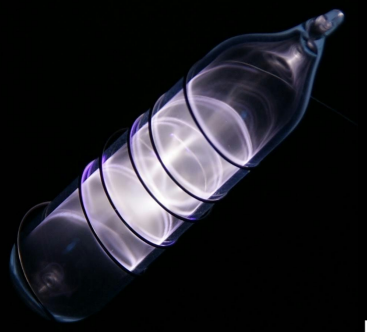
Krypton

Krypton is the fourth noble gas in the periodic table. It is also one of the most important ones.

Krypton gas-filled (discharge tube) sign. This one is a pale orange.

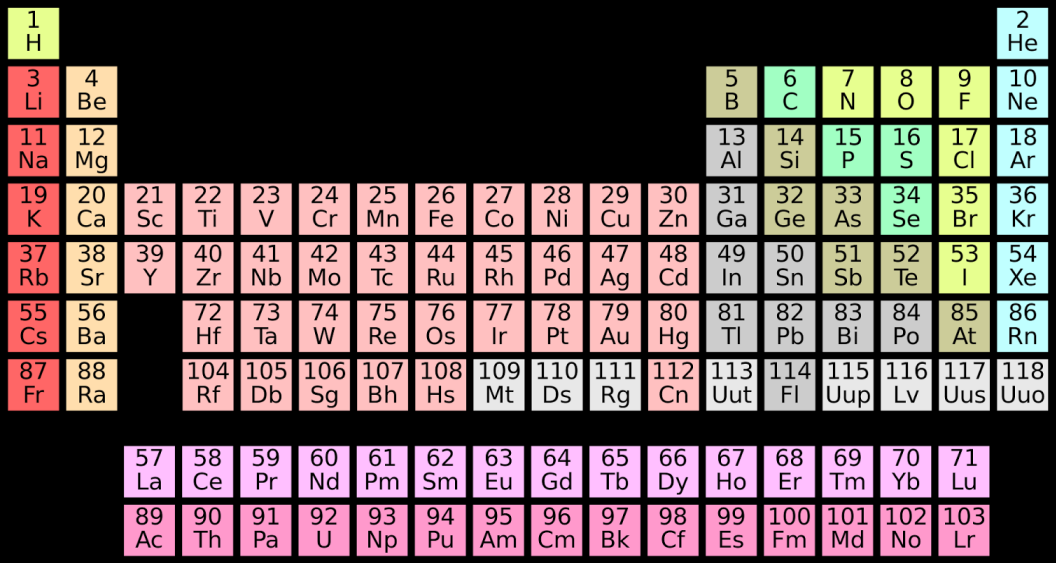
Krypton gas-filled (discharge tube) sign with a different color; it has a blue color.

Krypton is used along with other noble gases in fluorescent light bulbs. Krypton is naturally colorless, as with nearly all other noble gases.



Krypton gas bottle. This bottle shows krypton as a pale pink color.

Where Krypton is in the periodic table



Krypton is located right after bromine in the halogen group (Br), below the noble gas Argon, and above Xenon.

Uses of Krypton

Krypton has other uses, apart from being used in fluorescent light bulbs. It is used in light and photography, and used in many kinds of art.
Krypton is also reacted with fluorine to form a krypton fluoride laser, and liquid krypton is used in many different kinds of uses. However, most people use liquid argon, mainly because it is cheaper.

Krypton was discovered by Morris Travers and Sir William Ramsay. Sir William Ramsay also discovered helium, neon, argon, and xenon.

Xenon

The heaviest of the stable noble gases, xenon is the last one that is used in many products.

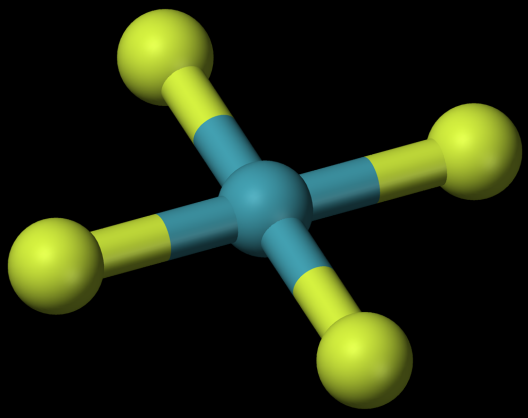
Xenon has an atomic mass of about 138. That is nearly 30 times heavier than the lightest of the noble gases, helium.

Xenon, like all other noble gases, has many uses, liquid and gas.

When electrons in xenon gas-filled (discharge tubes) get excited, they produce a bluish color.

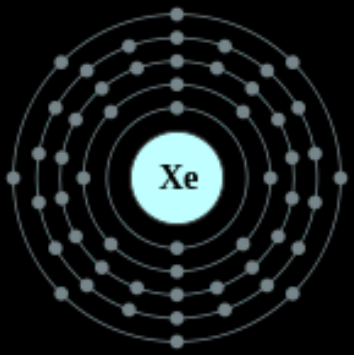
Xenon has many uses as a gas. It is used in cameras to give them a “flash” which helps freeze a moving object and thus helps get better film.

Xenon is also one of the most reactive of its group. Xenon does react with fluorine.



Xenon tetrafluoride. This is just one of three fluorine compounds that can be made with xenon.

Xenon has a complex atomic structure. The inner shell has 2 electrons, while the outer shell has nearly 32 electrons.



Xenon atomic structure.

Liquid xenon is also very important. A machine in Italy powered on ultra-blue liquid xenon is used to find dark matter.

Xenon gas bottle. The element is giving off a bluish color, which is the typical xenon color. It is similar to krypton when put in a discharge tube.

Where xenon is in the periodic table

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

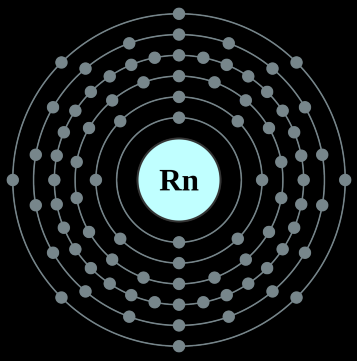
57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Xenon is located right after the halogen Iodine (I), above Radon (Rn), and below Krypton.

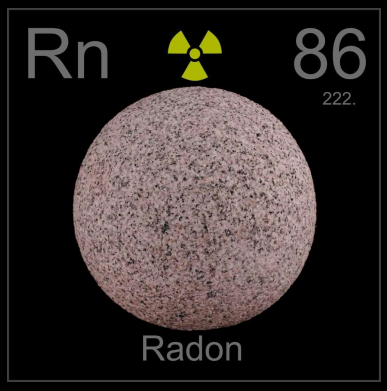
Xenon has an atomic number of 54. That means that it has 54 protons and electrons in it's nucleus.

Radon

Radon is the last of the noble gases. It is highly radioactive, and thus has no use in everyday life. Radon, however, can be contained in tubes. They will glow green because of radon's radioluminescence.



Radon's electron shells. It is the heaviest of all the noble gases.

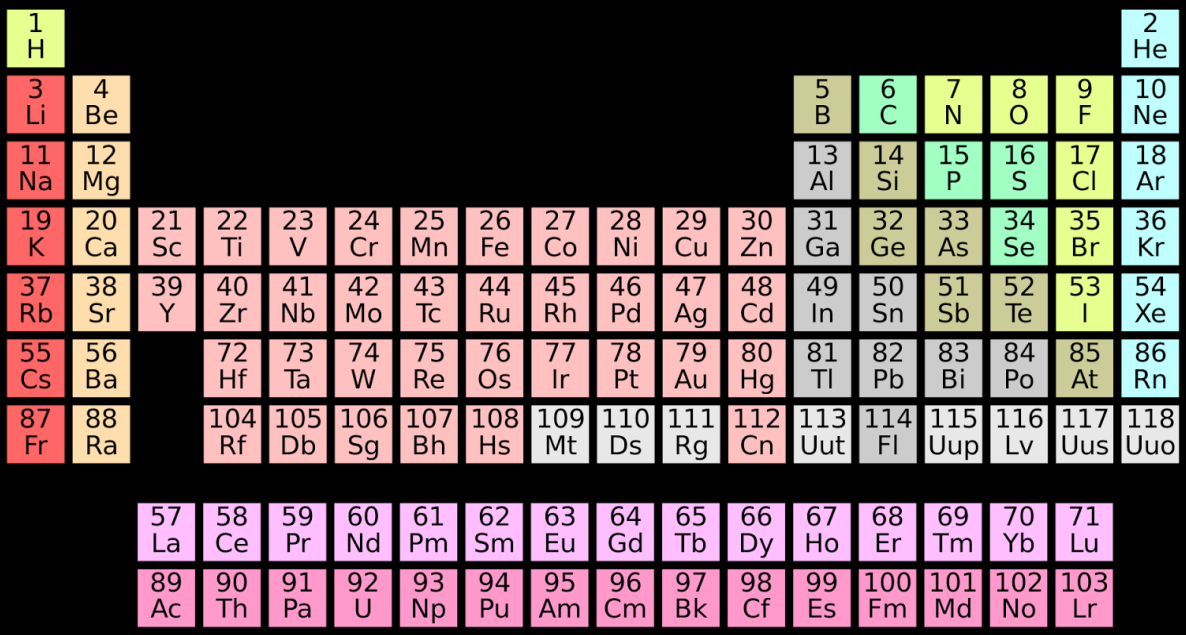


Radon in the periodic table. This represents uranium and thorium. Since these elements are radioactive, when they decay, radon is their decay product.

Radon is the last element in the sixth row of the periodic table.

Where Radon is in the periodic table

Radon is located on the end of the sixth row, next to the radioactive halogen astatine (At), below the noble gas xenon, and above the synthesized radioactive element Ununoctium (Uuo).



Radon in the periodic table. It is in the sixth row of the periodic table, and it has an atomic number of 86.

Dangers

Radon is a dangerous element. Radon poisoning has occurred in many homes. To stop the poisoning, many people install radon detectors in their houses.

Radon can leak into water, and drinking this water is unsafe. People die from radon poisoning in many places.

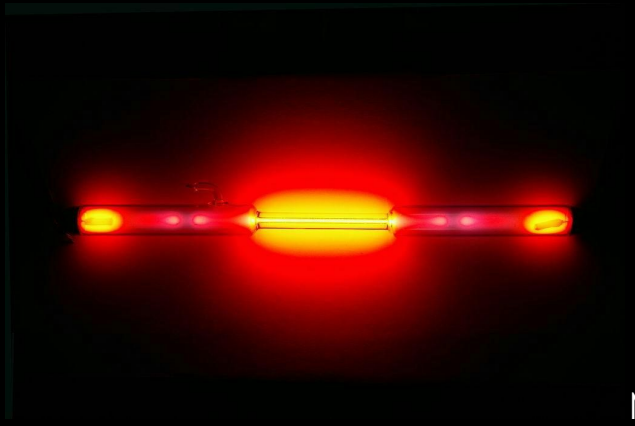
Glossary

A

Airship a large balloon-like object filled with helium so it can float.
Argon (Ar) a colorless noble gas that has an atomic number of 18. Argon emits a purple-pink color when in a discharge tube. It also emits a blue-green laser light.
Astatine (At). A radioactive halogen that has an atomic number of 18. Astatine can be found deep within the earth's crust.
Atom one of the fundamental building blocks of life. Atoms have a nucleus made up of electrons, neutrons, and protons.
Atomic number the number of protons that an element has.
Atomic structure A central nucleus of protons and neutrons surrounded by electrons.

C

Carbon (C) an element in the periodic table. Carbon is one of the building blocks of life.
Chlorine (Cl) a poisonous yellow-green gas. It has an atomic number of 17, and it is right before the noble gas argon.



Neon discharge tube glowing reddish-orange.

D

Decay product When two radioactive elements decay, new radioactive elements form. That is their decay product.

E

Electronegativity A chemical property that describes the tendency of an atom and a function group to attract electrons.

F

Fluorine (F) an element that is the most electronegative element in the periodic table.

I

Iodine (I) an element that is a violet-black solid. It vaporizes into a violet gas. It is found in brine wells.

O

Oxygen (O) an element that is in natural form a gas. Oxygen turns into a pale blue liquid at -183˚F.

P

Periodic table a grouping that consists of 118 elements.

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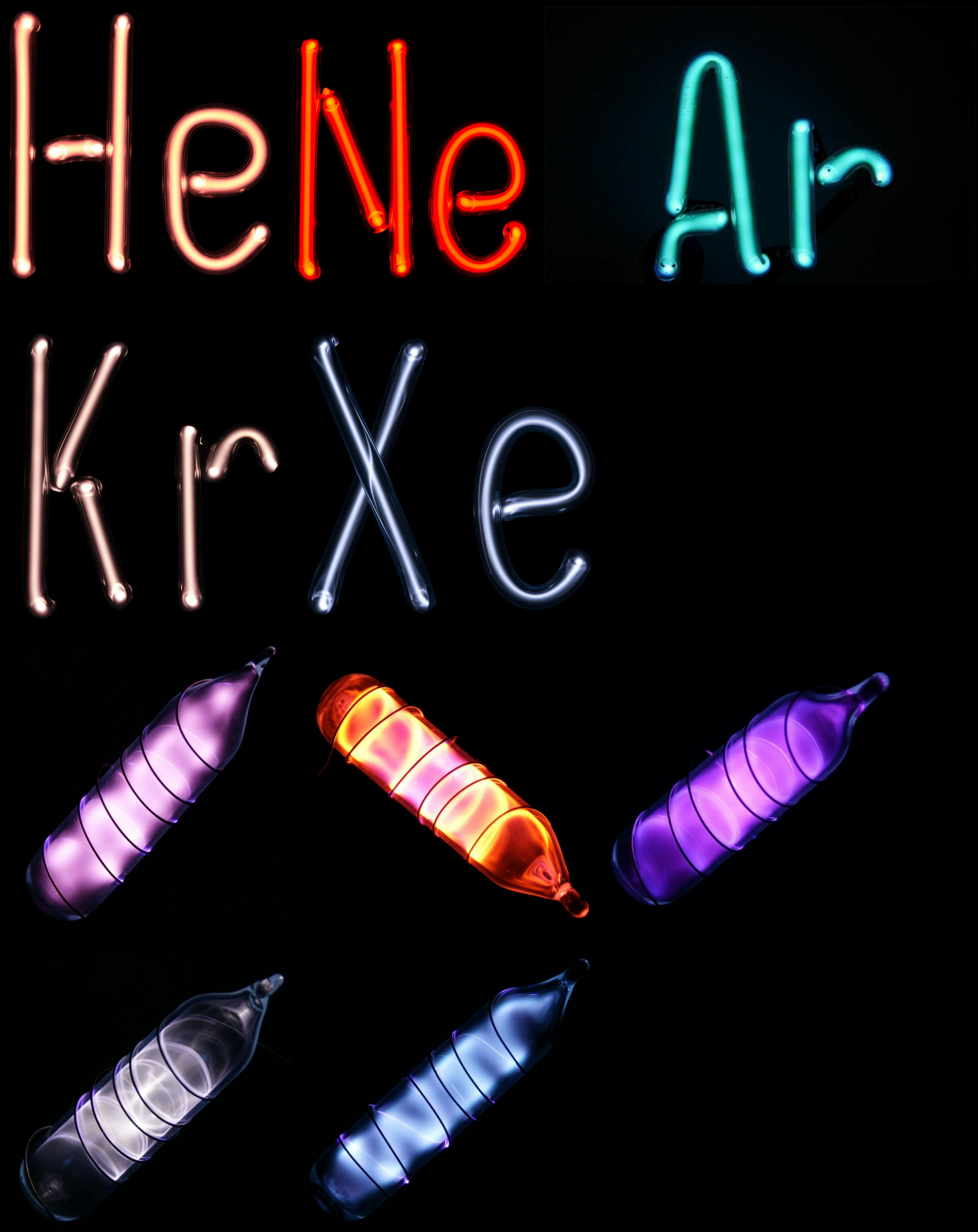
He
Ne
Ar
Kr
Xe