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Here's how you know



MENU

Radiation Protection

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Radiation Basics

Dose Calculator

Estimate your yearly dose <<https://epa.gov/radiation/calculate-your-radiation-dose>> from the most common sources of ionizing radiation with this interactive online dose calculator.



Radiation is energy. It can come from unstable atoms that undergo radioactive decay <<https://epa.gov/radiation/radioactive-decay>>, or it can be produced by machines. Radiation travels from its source in the form of energy waves or energized particles. There are different forms of radiation and they have different properties and effects.

Related information in Spanish (Información relacionada en español)

<<https://espanol.epa.gov/espanol/informacion-basica-sobre-la-radiacion>>

On this page:

- Ionizing and non-ionizing radiation
- Electromagnetic spectrum
- Types of ionizing radiation
- Periodic Table

Non-Ionizing and Ionizing Radiation

There are two kinds of radiation: non-ionizing radiation and ionizing radiation.

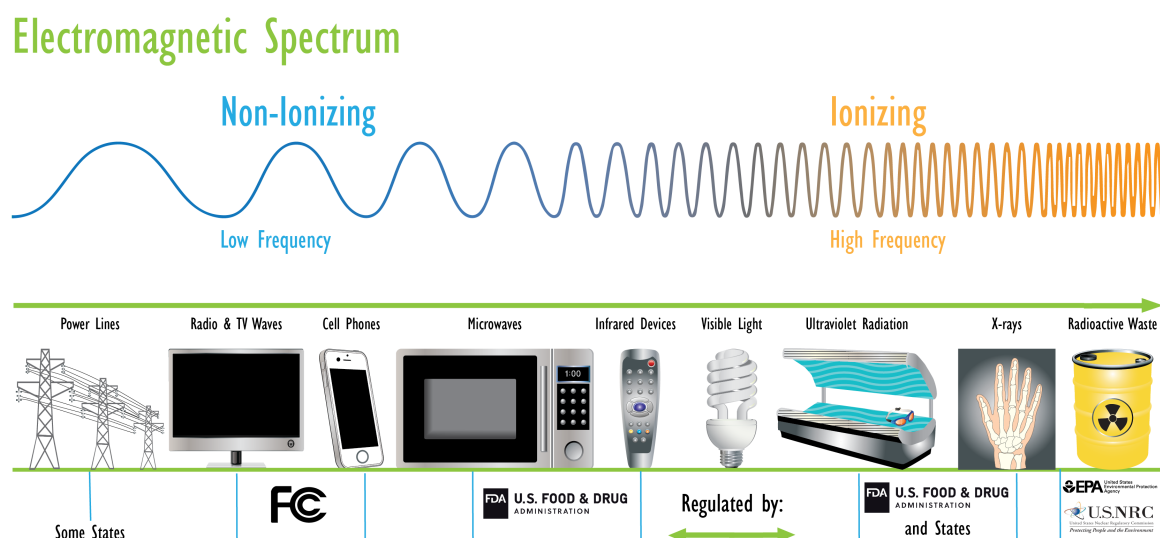
Non-ionizing radiation has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons from atoms. Examples of this kind of radiation are radio waves, visible light and microwaves.

Ionizing radiation has so much energy it can knock electrons out of atoms, a process known as ionization. Ionizing radiation can affect the atoms in living things, so it poses a health risk by damaging tissue and DNA in genes. Ionizing radiation comes from x-ray machines, cosmic particles from outer space and radioactive elements. Radioactive elements emit ionizing radiation as their atoms undergo radioactive decay.

Radioactive decay <https://epa.gov/radiation/radioactive-decay> is the emission of energy in the form of ionizing radiation. The ionizing radiation that is emitted can include alpha particles, beta particles and/or gamma rays. Radioactive decay occurs in unstable atoms called radionuclides <https://epa.gov/radiation/radionuclides>.

Electromagnetic Spectrum

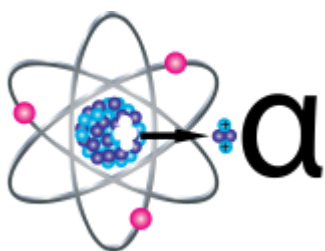
The energy of the radiation shown on the spectrum below increases from left to right as the frequency rises.



EPA's mission in radiation protection is to protect human health and the environment from the ionizing radiation that comes from human use of radioactive elements. Other agencies regulate the non-ionizing radiation that is emitted by electrical devices such as radio transmitters or cell phones (See: Radiation Resources Outside of EPA <<https://epa.gov/radiation/radiation-resources-outside-epa>>).

Types of Ionizing Radiation

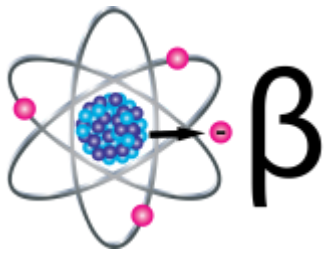
Alpha Particles



Alpha particles (α) are positively charged and made up of two protons and two neutrons from the atom's nucleus. Alpha particles come from the decay of the heaviest radioactive elements, such as uranium <<https://epa.gov/radiation/radionuclide-basics-uranium>>, radium <<https://epa.gov/radiation/radionuclide-basics-radium>> and polonium. Even though alpha particles are very energetic, they are so heavy that they use up their energy over short distances and are unable to travel very far from the atom.

The health effect from exposure to alpha particles depends greatly on how a person is exposed. Alpha particles lack the energy to penetrate even the outer layer of skin, so exposure to the outside of the body is not a major concern. Inside the body, however, they can be very harmful. If alpha-emitters are inhaled, swallowed, or get into the body through a cut, the alpha particles can damage sensitive living tissue. The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionizations they cause are very close together - they can release all their energy in a few cells. This results in more severe damage to cells and DNA.

Beta Particles



Beta particles (β) are small, fast-moving particles with a negative electrical charge that are emitted from an atom's nucleus during radioactive decay. These particles are emitted by certain unstable atoms such as hydrogen-3 (tritium

<https://epa.gov/radiation/radionuclide-basics-tritium>), carbon-14 and strontium-90

<https://epa.gov/radiation/radionuclide-basics-strontium-90>.

Beta particles are more penetrating than alpha particles, but are less damaging to living tissue and DNA because the ionizations they produce are more widely spaced. They travel farther in air than alpha particles, but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminum. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.

Gamma Rays



Gamma rays (γ) are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are similar to visible light, but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers that can stop alpha and beta particles, such as skin and clothing. Gamma rays have so much penetrating power that several inches of a dense material like

lead, or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body; as they pass through, they can cause ionizations that damage tissue and DNA.

X-Rays



Because of their use in medicine, almost everyone has heard of x-rays. X-rays are similar to gamma rays in that they are photons of pure energy. X-rays and gamma rays have the same basic properties but come from different parts of the atom. X-rays are emitted from processes outside the nucleus, but gamma rays originate inside the nucleus. They also are generally lower in energy and, therefore less penetrating than gamma rays. X-rays can be produced naturally or by machines using electricity.

Literally thousands of x-ray machines are used daily in medicine. Computerized tomography, commonly known as a CT or CAT scan, uses special x-ray equipment to make detailed images of bones and soft tissue in the body. Medical x-rays are the single largest source of man-made radiation exposure. Learn more about radiation sources and doses. <<https://epa.gov/radiation/radiation-sources-and-doses>> X-rays are also used in industry for inspections and process controls.

Periodic Table

Elements in the periodic table can take on several forms. Some of these forms are stable; other forms are unstable. Typically, the most stable form of an element is the most common in nature. However, all elements have an unstable form. Unstable

forms emit ionizing radiation and are radioactive. There are some elements with no stable form that are always radioactive, such as uranium. Elements that emit ionizing radiation are called radionuclides.

<<https://epa.gov/sites/default/files/2017-11/periodic-table-radioactive-elements.png>>

Periodic Table of Radioactive Elements																																			
1 H 1.008 Hydrogen																2 He 4.003 Helium																			
3 Li 6.94 Lithium		4 Be 9.012 Beryllium																5 B 10.81 Boron		6 C 12.011 Carbon		7 N 14.007 Nitrogen		8 O 15.999 Oxygen		9 F 18.998 Fluorine		10 Ne 20.180 Neon							
11 Na 22.990 Sodium		12 Mg 24.305 Magnesium																13 Al 26.982 Aluminum		14 Si 28.085 Silicon		15 P 30.974 Phosphorus		16 S 32.06 Sulfur		17 Cl 35.45 Chlorine		18 Ar 39.948 Argon							
19 K 39.098 Potassium		20 Ca 40.078 Calcium		21 Sc 44.956 Scandium		22 Ti 47.867 Titanium		23 V 50.942 Vanadium		24 Cr 51.996 Chromium		25 Mn 54.938 Manganese		26 Fe 55.845 Iron		27 Co 58.933 Cobalt		28 Ni 58.693 Nickel		29 Cu 63.546 Copper		30 Zn 65.38 Zinc		31 Ga 69.723 Gallium		32 Ge 72.630 Germanium		33 As 74.922 Arsenic		34 Se 78.971 Selenium		35 Br 79.904 Bromine		36 Kr 83.798 Krypton	
37 Rb 85.468 Rubidium		38 Sr 87.62 Strontium		39 Y 88.906 Yttrium		40 Zr 91.224 Zirconium		41 Nb 92.906 Niobium		42 Mo 95.95 Molybdenum		43 Tc (98) Technetium		44 Ru 101.07 Ruthenium		45 Rh 102.906 Rhodium		46 Pd 106.42 Palladium		47 Ag 107.868 Silver		48 Cd 112.414 Cadmium		49 In 114.818 Indium		50 Sn 118.710 Tin		51 Sb 121.760 Antimony		52 Te 127.60 Tellurium		53 I 126.904 Iodine		54 Xe 131.293 Xenon	
55 Cs 132.905 Cesium		56 Ba 137.327 Barium		57 / 71		72 Hf 178.49 Hafnium		73 Ta 180.948 Tantalum		74 W 183.84 Tungsten		75 Re 186.207 Rhenium		76 Os 190.23 Osmium		77 Ir 192.217 Iridium		78 Pt 195.084 Platinum		79 Au 196.967 Gold		80 Hg 200.592 Mercury		81 Tl 204.38 Thallium		82 Pb 207.2 Lead		83 Bi 208.980 Bismuth		84 Po (209) Polonium		85 At (210) Astatine		86 Rn (222) Radon	
87 Fr (223) Francium		88 Ra (226) Radium		89 / 103		104 Rf (261) Rutherfordium		105 Db (268) Dubnium		106 Sg (271) Seaborgium		107 Bh (270) Bohrium		108 Hs (269) Hassium		109 Mt (278) Meitnerium		110 Ds (281) Darmstadtium		111 Rg (282) Roentgenium		112 Cn (285) Copernicium		113 Nh (286) Nihonium		114 Fl (289) Flerovium		115 Mc (289) Moscovium		116 Lv (293) Livermorium		117 Ts (294) Tennessine		118 Og (294) Oganesson	
Lanthanide Series		57 La 138.905 Lanthanum		58 Ce 140.116 Cerium		59 Pr 140.908 Praseodymium		60 Nd 144.242 Neodymium		61 Pm (145) Promethium		62 Sm 150.36 Samarium		63 Eu 151.964 Europium		64 Gd 157.25 Gadolinium		65 Tb 158.925 Terbium		66 Dy 162.500 Dysprosium		67 Ho 164.930 Holmium		68 Er 167.259 Erbium		69 Tm 168.934 Thulium		70 Yb 173.045 Ytterbium		71 Lu 174.967 Lutetium					
Actinide Series		89 Ac (227) Actinium		90 Th 232.038 Thorium		91 Pa 231.036 Protactinium		92 U 238.029 Uranium		93 Np (237) Neptunium		94 Pu (244) Plutonium		95 Am (243) Americium		96 Cm (247) Curium		97 Bk (247) Berkelium		98 Cf (251) Californium		99 Es (252) Einsteinium		100 Fm (257) Fermium		101 Md (258) Mendelevium		102 No (259) Nobelium		103 Lr (266) Lawrencium					

*() indicates the mass number of the longest-lived isotope. Based on NIST 2017 Periodic Table

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