ORTEC®

AN34 Glossary

Absorption Coefficient: Fractional decrease in the intensity of a beam of x- or gamma-radiation per unit thickness (linear absorption coefficient), per unit mass (mass absorption coefficient), or per atom (atomic absorption coefficient) of absorber, due to deposition of energy in the absorber. The total absorption coefficient is based on the sum of individual energy absorption processes (Compton effect, photoelectric effect, and pair production).

Absorption Coefficient, Atomic: The linear absorption coefficient of a nuclide divided by the number of atoms per unit volume of the nuclide. It is equivalent to the nuclide's total cross section for the given radiation.

Absorption Coefficient, Compton: That fractional decrease in the energy of a beam of x- or gamma-radiation due to the deposition of the energy to electrons produced by Compton effect in an absorber. (See also Scattering, Compton.)

Absorption Coefficient, Linear: A factor expressing the fraction of a beam of x- or gamma-radiation absorbed in unit thickness of material. In the expression $I = I_0 e^{-\mu x}$, I_0 is the initial intensity, I is the intensity of the beam after passage through a thickness, x, of the material, and μ is the linear absorption coefficient.

Absorption Coefficient, Mass: The linear absorption coefficient per cm divided by the density of the absorber in grams per cm^3. It is frequently expressed as μ/ρ, where μ is the linear absorption coefficient and ρ the absorber density.

Alpha Particle: A helium nucleus, consisting of two protons and two neutrons, with a double positive charge.

Analysis, Activation: A method of chemical analysis, especially for small traces of material, based on the detection of characteristic radionuclides following a nuclear bombardment.

Analysis, Feather: A technique for the determination of the range in aluminum of the beta particles of a radio-element by comparison of the absorption curve with the absorption curve of a reference series, usually ^{210}Bi (range 501 mg/cm^2).

Angstrom Unit (Å): One angstrom unit equals 10^{-8} cm.

Atomic Number: The number of orbital electrons surrounding the nucleus of a neutral atom and according to present theory the number of protons in the nucleus (Symbol: Z).

Attenuation: The process by which a beam of radiation is reduced in intensity when passing through some material. It is the combination of absorption and scattering processes and leads to a decrease in flux density of the beam when projected through matter.

Attenuation Coefficient, Compton: The fractional number of photons removed from a beam of radiation per unit thickness of a material through which it is passing as a result of Compton effect interactions.

Attenuation Factor: A measure of the opacity of a layer of material for radiation traversing it; the ratio of the incident intensity to the transmitted intensity. It is equal to I_0/I, where I_0 and I are the intensities of the incident and emergent radiation, respectively. In the usual sense of exponential absorption ($I = I_0 e^{-\mu x}$) the attenuation factor is $e^{-\mu x}$, where x is the thickness of the material, and μ is the absorption coefficient.

Auger Effect: The emission of an electron from the extra-nuclear portion of an excited atom when the atom under goes a transition to a less excited state.

Average Life (Mean Life): The average of the individual lives of all the atoms of a particular radioactive substance. It is 1.443 times the radioactive half-life.

Avogadro's Number (6.025×10^{23} physical scale): Number of atoms in a gram atomic weight of any element, also the number of molecules in the gram molecular weight of any substance.

Backscattering: The deflection of radiation by scattering processes through angles >90° with respect to the original direction of motion.

Barn: Unit expressing the probability of specific nuclear reaction taking place in terms of cross-sectional area. Numerically it is 10^{-24} cm^2.

Beta Particle: Charged particle emitted from the nucleus of an atom and having a mass and charge equal in magnitude to those of the electron.

Branching: The occurrence of two or more modes by which a radionuclide can undergo radioactive decay. For example, RaC can undergo α and β decay. ^{64}Cu can undergo β^-, β^+, and electron capture decay. An individual atom of a nuclide exhibiting branching disintegrates by one mode only. The fraction disintegrating by a particular mode is the branching fraction for that mode. The branching ratio is the ratio of two specified branching fractions (synonym: multiple disintegration).

Bremsstrahlung: Secondary photon radiation produced by deceleration of charged particles passing through matter.

Capture, Electron: A mode of radioactive decay involving the capture of an orbital electron by its nucleus. Capture from a particular electron shell is designated a K-electron capture, L-electron capture, etc.

Capture, K-Electron: Electron capture from the K shell by the nucleus of the atom. Also loosely used to designate any orbital electron-capture process.

Capture, Radiative: The process by which a nucleus captures an incident particle and loses its excitation energy immediately by the emission of gamma radiation.

Compton Effect: An attenuation process observed for x- or gamma-radiation in which an incident photon interacts with an orbital electron of an atom to produce a recoil electron and a scattered photon of energy less than the incident photon.

AN34 Glossary

Conversion, Internal: A mode of radioactive decay in which the gamma rays from excited nuclei cause the ejection of orbital electronics from the atom. The ratio of the number of internal conversion electrons to the number of gamma quanta emitted in the de-excitation of the nucleus is called the "conversion ratio."

Cosmic Rays: High energy particulate and electromagnetic radiations which originate outside of the earth's atmosphere.

Coulomb: Unit of electrical charge in the practical system of units. A quantity of electricity equal to 3×10^9 electrostatic units of charge.

Cross Section, Nuclear: The probability that a certain reaction between a nucleus and an incident particle or photon will occur. It is expressed as the effective "area" that the nucleus presents for the reaction. (See Barn.) Macroscopic cross section refers to the cross section per unit volume (preferably) or per unit mass. Microscopic cross section is the cross section of one atom or molecule.

Decay, Radioactive: Disintegration of the nucleus of an unstable nuclide by the spontaneous emission of charged particles and/or photons.

Delta Ray: Any secondary ionizing particle ejected by recoil when a primary ionizing particle passes through matter.

Deuterium: A heavy isotope of hydrogen having one proton and one neutron in the nucleus (Symbol: D or ${}^2_1H$).

Disintegration, Constant: The fraction of the number of atoms of a radioactive nuclide which decay in unit time; λ in the equation $N = N_0e^{-\lambda t}$, where N_0 is the initial number of atoms present and N is the number of atoms present after some time, t.

Disintegration, Nuclear: A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus. When numbers of nuclei are involved, the process is characterized by a definite half-life.

Electron: Negatively charged particle which is a constituent of every neutral atom. Unit of negative electricity equal to 4.8×10^{-10} electrostatic units or 1.6×10^{-19} coulomb. Its mass is 0.000549 atomic mass units.

Electron Volt (eV): A unit of energy equivalent to the amount of energy gained by an electron in passing through a potential difference of 1 volt. Larger multiple units of the electron volt are frequently used, viz: keV for thousand or kilo electron volts, MeV for million electron volts, and BeV for billion electron volts; $1 \text{ eV} = 1.6 \times 10^{-12}$ erg.

Element: Pure substance consisting of atoms of the same atomic number which cannot be decomposed by ordinary chemical means.

Emulsion, Nuclear: A photographic emulsion specially designed to permit observation of the individual tracks of ionizing particles.

Energy: Capacity of doing work. Potential energy is the energy inherent in a mass because of its position with reference to other masses. Kinetic energy is the energy possessed by a mass because of its motion; cgs units: $g–cm^2/s^2$ or ergs.

Energy, Binding: The energy represented by the difference in mass between the sum of the component parts and the actual mass of the nucleus.

Energy, Excitation: The energy required to change a system from its ground state to an excited state. With each different excited state there is associated a different excitation energy.

Energy, Ionizing: The average energy lost by ionizing radiation in producing an ion pair in a gas. For air it is about 33 eV.

Energy, Radiant: The energy of electromagnetic waves, such as radio waves, visible light, x rays and gamma rays.

Energy, Reaction (Nuclear): In the disintegration of a nuclear reaction, it is equal to the sum of the kinetic or radiant energies of the reactants minus the sum of the kinetic or radiant energies of the products. (If any product of a specified reaction is in an excited nuclear state, the energy of subsequently emitted gamma radiation is not included in the sum.) The ground-state nuclear reaction energy is the reaction energy when all reactant and product nuclei are in their ground states (Symbol: Q_0).

Excitation: The addition of energy to a system, thereby transferring it from its ground state to an excited state. Excitation of a nucleus, an atom, or a molecule can result from absorption of photons or from inelastic collisions with other particles.

Fluorescence: The emission of radiation of particular wavelengths by a substance as a result of absorption of radiation of shorter wavelength. This emission occurs essentially only during the irradiation.

Flux: For electromagnetic radiation, the quantity of radiant energy flowing per unit time. For particles and photons, the number of particles or photons flowing per unit time.

Gamma Ray: Short wavelength electromagnetic radiation of nuclear origin with a range of wavelengths from about 10^{-8} to 10^{-11} cm, emitted from the nucleus.

Geiger Region: In an ionization radiation detector, the operating voltage interval in which the charge collected per ionizing event is essentially independent of the number of primary ions produced in the initial ionizing event.

Geiger Threshold: The lowest voltage applied to a counter tube for which all pulses produced in the counter tube are of substantially the same size, regardless of the size of the primary ionizing event.

Geometry, Good: In nuclear physics measurements, an arrangement of source and detecting equipment so that the use of finite source size and finite detector aperture introduces little error.

Gram Atomic Weight: A mass in grams numerically equal to the atomic weight of an element.

Half-Life, Radioactive: Time required for a radioactive substance to lose 50% of its activity by decay. Each radionuclide has a unique half-life.

Half Value Layer (Half Thickness): The thickness of any particular material necessary to reduce the intensity of an x-ray or gamma-ray beam to one-half its original value.

Ionization: The process or the result of any process by which a neutral atom or molecule acquires either a positive or a negative charge.

Ionization, Total: The total electric charge of one sign on the ions produced by radiation in the process of losing all of its kinetic energy. For a given gas, the total ionization is closely proportional to the initial ionization and is nearly independent of the nature of the ionizing radiation. It is frequently used as a measure of radiation energy.

Ion Pair: Two particles of opposite charge, usually referring to the electron and positive atomic or molecular residue resulting after the interaction of ionizing radiation with the orbital electrons of atoms.

Isobar: One of two or more different nuclides having the same mass number but differing in atomic number. Originally called isobares but the name “isobars” is now generally employed.

Isomer: One of several nuclides having the same number of neutrons and protons but capable of existing, for a measurable time, in different quantum states with different energies and radioactive properties. Commonly, the isomer of higher energy decays to one with lower energy by the process of isomeric transition.

Isotope: One of several nuclides having the same number of protons in their nuclei, and hence having the same atomic number, but differing in the number of neutrons, and therefore in the mass number. Almost identical chemical properties exist between isotopes of a particular element. The use of this term as a synonym for nuclide is to be discouraged.

Isotope, Stable: A nonradioactive isotope of an element.

keV: The symbol for 1000 electron volts, or 10^3 eV.

Mass Number: The number of nucleons (protons and neutrons) in the nucleus of an atom.

MeV: The symbol for 1 million electron volts, or 10^6 eV.

Micron: Unit of length equal to 10^{-6} meter. Preferred usage is “micrometer.” Use of “micro” is discouraged by IUPAP.

Mil: Linear measurement unit equal to one-thousandth of an inch.

Neutrino: A neutral particle of very small rest mass postulated to account for the continuous distribution of energy among the particles in the beta-decay process and to allow for conservation of momentum in beta decay.

Neutron: Elementary nuclear particle with a mass approximately the same as that of a hydrogen atom and electrically neutral; its mass is 1.008982 mass units. Neutrons are commonly divided into sub-classifications according to their energies as follows: thermal, around 0.025 eV; epithermal, 0.1 eV to 100 eV; slow, <100 eV; intermediate, 10^2 to 10^5 eV; fast, >0.1 MeV.

Nucleon: Common name for a constituent particle of the nucleus; applied to protons and neutrons, but will include any other particle found to exist in the nucleus.

Nucleus (Nuclear): That part of an atom in which the total positive electric charge and most of the mass are concentrated.

Nuclide: A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, Z, number of neutrons, N, and energy content; or alternatively, by the atomic number Z, mass number A = (N + Z), and atomic mass. To be regarded as a distinct nuclide, the atom must be capable of existing for a measurable time; thus nuclear isomers are separate nuclides, whereas promptly decaying excited nuclear states and unstable intermediates in nuclear reactions are not so considered.

Pair Production: An absorption process for x- and gamma-radiation in which the incident photon is annihilated in the vicinity of the nucleus of the absorbing atom with subsequent production of an electron and positron pair. This reaction only occurs for incident photon energies exceeding 1.02 MeV.

Photoelectric Effect: A process by which a photon ejects an electron from an atom. All the energy of the photon is absorbed in ejecting the electron and in imparting kinetic energy to it.

Photon: A quantity of electromagnetic energy whose value in ergs is the product of its frequency in cycles/s and Planck’s constant. The equation is: $E = h\upsilon$.

Planck’s Constant: A natural constant of proportionality, (h), relating the frequency of a quantum of energy to the total energy of the quantum:

$$h = \frac{E}{\upsilon} = 6.624 \times 10^{-27} \text{ erg-s}$$

Positron: Particle equal in mass to the electron and having and equal but opposite charge.

Power, Stopping: A measure of the effect of a substance upon the kinetic energy of a charged particle passing through it.

Rare Earth: Any of the series of very similar metals ranging in atomic number from 57 through 71.

Reaction (Nuclear): An induced nuclear disintegration, that is, a process occurring when a nucleus comes into contact with a photon, an elementary particle, or another nucleus. In many cases the reaction can be represented by the symbolic equation: $X + a \rightarrow Y + b$ or, in abbreviated form, X(a,b)Y, in which X is the target nucleus, a is the incident particle or photon, b is an emitted particle or photon, and Y is the product nucleus.

Roentgen: An exposure dose of x- or gamma-radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying 1 electrostatic unit of quantity of electricity of either sign (abbreviated R).

Scattering: Change of direction of subatomic particle or photon as a result of a collision or interaction.

Scattering, Compton: The inelastic scattering of a photon through interaction with atomic electrons, accompanied by ejection of a recoil electron from the atom with which the interaction occurred. Compton-scattered photons carry away a fraction of the incident photon energy, ranging from an average of about 85% of the initial energy for a 0.1 MeV photon to an average of about 30% for a 10 MeV photon. Sometimes referred to as incoherent scattering.

Scattering, Elastic: Scattering effected through the agency of elastic collisions and therefore with conservation of kinetic energy of the system. Rayleigh scattering is a form of elastic scattering.

Scattering, Inelastic: The type of scattering which results in the nucleus being left in an excited state and the total kinetic energy being decreased.

Time Units: Standardized abbreviations for time units are:

1 y = 1 year
1 d = 1 day
1 h = 1 hour
1 min = 1 minute
1 s = 1 second
1 ms = 1 millisecond = 10^{-3} s
1 μs = 1 microsecond = 10^{-6} s
1 ns = 1 nanosecond = 10^{-9} s
1 ps = 1 picosecond = 10^{-12} s

Tritium: ($^{3}_{1}$H or T) The hydrogen isotope having one proton and two neutrons in the nucleus.

X-Rays: Penetrating electromagnetic radiations having wavelengths shorter than those of visible light. They are usually produced by bombarding a metallic target with fast electrons in a high vacuum. In nuclear reactions it is customary to refer to photons originating in the nucleus as gamma rays and those originating in the extranuclear part of the atom as x rays. These rays are sometimes called roentgens, after their discoverer, W.C. Roentgen.

Specifications subject to change
030110

ORTEC®
www.ortec-online.com
Tel. (865) 482-4411 • Fax (865) 483-0396 • ortec.info@ametek.com
801 South Illinois Ave., Oak Ridge, TN 37831-0895 U.S.A.
For International Office Locations, Visit Our Website

AMETEK®
ADVANCED MEASUREMENT TECHNOLOGY