

# **Nuclear Chemistry**

## **Sound Records**

### **Sound Records:**

Radioactivity

Chemical Elements

General Chemistry Vocabulary

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## Radioactivity

Radioactivity was discovered in 1896 by the French scientist Henri Becquerel, while working on phosphorescent materials. These materials glow in the dark after exposure to light, and he suspected that the glow produced in cathode ray tubes by X-rays might be associated with phosphorescence. He wrapped a photographic plate in black paper and placed various phosphorescent salts on it. All results were negative until he used uranium salts. The result with these compounds was to cause a blackening of the plate in spite of the plate being wrapped in black paper. These radiations were given the name "Becquerel Rays".

It soon became clear that the blackening of the plate had nothing to do with phosphorescence, as the plate recorded the presence of the mineral while wrapped and non-phosphorescent salts of uranium and metallic uranium also blackened the plate. It was clear that there was a form of invisible radiation that could pass through paper and was causing the plate to react as if exposed to light and so become black.

At first, it seemed as though the new radiation was similar to the then recently discovered X-rays. Further research by Becquerel, Ernest Rutherford, Paul Villard, Pierre Curie, Marie Curie, and others showed that this form of radioactivity was significantly more complicated. Rutherford was the first to realize that they all decay in accordance with the same mathematical exponential formula, and Rutherford and his student Frederick Soddy were the first to realize that many decay processes resulted in the transmutation of one element to another. Subsequently, the radioactive displacement law of Fajans and Soddy was formulated to describe the products of alpha and beta decay.

The early researchers also discovered that many other chemical elements, besides uranium, have radioactive isotopes. A systematic search for the total radioactivity in uranium ores also guided Pierre and Marie Curie to isolate two new elements: polonium and radium. Except for the radioactivity of radium, the chemical similarity of radium to barium made these two elements difficult to distinguish.

The dangers of radioactivity and radiation were not immediately recognized. The discovery of x-rays in 1895 led to widespread experimentation by scientists, physicians, and inventors. Many people began recounting stories of burns, hair loss and worse in technical journals as early as 1896. In February of that year, Professor Daniel and Dr. Dudley of Vanderbilt University performed an experiment involving x-raying Dudley's head that resulted in his hair loss. A report by Dr. H.D. Hawks, a graduate of Columbia College, of his suffering severe hand and chest burns in an x-ray demonstration, was the first of many other reports in *Electrical Review*. Many experimenters including Elihu Thomson at Thomas Edison's lab, William J. Morton, and Nikola Tesla also reported burns. Elihu Thomson deliberately exposed a finger to an x-ray tube over a period of time and suffered pain, swelling, and blistering. Other effects, including ultraviolet rays and ozone were sometimes blamed for the damage. Many physicians claimed that there were no effects from x-ray exposure at all.

Before the biological effects of radiation were known, many physicians and corporations began marketing radioactive substances as patent medicine in the form of glow-in-the-dark pigments. Examples were radium enema treatments, and radium-

containing waters to be drunk as tonics. Marie Curie protested against this sort of treatment, warning that the effects of radiation on the human body were not well understood. Curie later died from aplastic anaemia, likely caused by exposure to ionizing radiation. By the 1930s, after a number of cases of bone necrosis and death of radium treatment enthusiasts, radium-containing medicinal products had been largely removed from the market (radioactive quackery).

# Chemical Elements

Actinium  
Aluminium  
Aluminum  
Americium  
Antimony  
Argon  
Arsenic  
Astatine  
Barium  
Berkelium  
Beryllium  
Bismuth  
Bohrium  
Boron  
Bromine  
Cadmium  
Caesium  
Calcium  
Californium  
Carbon  
Cerium  
Cesium  
Chlorine  
Chromium  
Cobalt  
Copernicium  
Copper  
Curium  
Darmstadtium  
Dubnium  
Dysprosium  
Einsteinium  
Erbium  
Europium  
Fermium  
Flerovium  
Fluorine  
Francium  
Gadolinium  
Gallium  
Germanium  
Gold  
Hafnium  
Hassium  
Helium  
Holmium  
Hydrogen  
Indium

Iodine  
Iridium  
Iron  
Krypton  
Lanthanum  
Lawrencium  
Lead  
Lithium  
Livermorium  
Lutetium  
Magnesium  
Manganese  
Meitnerium  
Mendelevium  
Mercury  
Molybdenum  
Neodymium  
Neon  
Neptunium  
Nickel  
Niobium  
Nitrogen  
Nobelium  
Osmium  
Oxygen  
Palladium  
Phosphorus  
Platinum  
Plutonium  
Polonium  
Potassium  
Praseodymium  
Promethium  
Protactinium  
Radium  
Radon  
Rhenium  
Rhodium  
Roentgenium  
Rubidium  
Ruthenium  
Rutherfordium  
Samarium  
Scandium  
Seaborgium  
Selenium  
Silicon  
Silver  
Sodium  
Strontium

Sulphur  
Tantalum  
Technetium  
Tellurium  
Terbium  
Thallium  
Thorium  
Thulium  
Tin  
Titanium  
Tungsten  
Ununoctium  
Ununpentium  
Ununseptium  
Ununtrium  
Uranium  
Vanadium  
Xenon  
Ytterbium  
Yttrium  
Zinc  
Zirconium

# General Vocabulary

absorbance  
absorption of radiation  
electron affinity  
actinides  
 $\alpha$ -helix  
aluminosilicate  
volumetric analysis  
gravimetric analysis  
aniline  
antiparticle  
activation barrier  
baryon  
soft base  
hard base  
benzene  
protein  
biochemistry  
stationary point  
borane  
boson  
intermediate boson  
butadiene  
reaction path  
 $\alpha$  particle  
 $\beta$  particle  
particle of force field  
atomic number  
Avogadro's number  
quantum number  
principal quantum number  
magnetic quantum number  
orbital angular momentum quantum number  
mass number  
proton number  
degeneracy of state  
bond length  
wavelength  
derivative  
deuterium  
diffusion  
dissociation  
particle-wave duality  
nonadiabatic effect  
electrolyte  
strong electrolyte  
weak electrolyte  
electrolysis  
electron  
electronegativity  
emission of radiation  
energy  
activation energy

total energy  
discrimination energy  
dissociation energy  
photon energy  
Gibbs (free) energy  
standard Gibbs energy  
Helmholtz energy  
kinetic energy  
zero-point energy  
orbital energy  
potential energy  
potential energy curve  
vibrational energy  
internal energy  
enthalpy  
enthalpy of reaction  
standard enthalpy of formation  
entropy  
enzyme  
ethylene  
fermion  
fluidity  
fluorescence  
phosphorescence  
photon  
collision frequency  
frequency of radiation  
function  
state function  
wave function  
symmetry properties of wave function  
electron wave function  
nuclear fusion  
gene  
geometry of molecule  
graphite  
graviton  
group  
point group  
hadron  
Hamiltonian  
helium  
atomic mass  
molecular mass  
electron density, distribution  
probability density  
(linear) momentum  
hybridization  
potential energy hypersurface  
analytical chemistry  
inorganic chemistry  
physical chemistry  
organic chemistry  
chirality



chromatography  
chromosome  
angular momentum  
genetic information  
graphical integration  
numerical integration  
integral  
indefinite integral  
constant of motion  
overlap integral  
definite integral  
Coulomb interaction  
electromagnetic interaction  
gravitational interaction  
strong interaction  
weak interaction  
hydrogen molecular ion  
insulator  
isomer  
atomic nucleus  
carcinogenic activity of hydrocarbons  
heat capacity  
catalysis  
acid catalysis  
hydronium cation  
cluster  
molar absorption coefficient  
expansion coefficient  
activated complex  
transition complex  
charge-transfer complex  
electron configuration  
dissociation constant  
Planck constant  
(universal) gas constant  
equilibrium constant  
rate constant  
energy continuum  
reaction coordinate  
ionic crystal  
liquid crystal  
covalent crystal  
molecular crystal  
potential-energy curve  
quantization  
quantization of energy  
quark  
deoxyribonucleic acid  
soft acid  
nucleic acid  
hard acid  
lanthanides  
laser  
amorphous solids

crystalline solids  
lepton  
ligand  
classical mechanics  
statistical mechanics  
donor-acceptor mechanism  
reaction mechanism  
metallocene  
metalloid  
reaction intermediate  
meson  
muon  
amount of substance  
antibonding MO  
bonding MO  
cyclic molecule  
molecularity of reaction  
angular momentum  
orbital angular momentum  
magnetic moment  
transition moment  
spin multiplicity  
naphthalene  
nonmetal  
indistinguishability of particles  
neutralization  
neutrino  
neutron  
nucleoside  
nucleotide  
nuclide  
molar volume  
inversion (operation)  
symmetry operation  
operator  
Hamilton operator (Hamiltonian)  
Laplace operator (Laplacian)  
atomic orbital  
hybrid orbital  
molecular orbital  
unoccupied (virtual) orbital  
occupied orbital  
valence orbital  
 $\pi$  orbital  
 $\delta$  orbital  
 $\sigma$  orbital  
symmetry axis  
electron pair  
absorption band  
energy band  
valence band  
conduction band  
period (row) of elements  
permittivity (dielectric constant)

pH, measure of acidity  
ideal gas  
real gas  
synthesis gas  
noble gas  
boundary condition  
initial condition  
computational experiment  
polarography  
half-life for radioactive decay  
semiconductor  
bathochromic shift  
hypsochromic shift  
ionization potential  
positron  
Hund rule  
rule of maximum multiplicity  
selection rule  
Heisenberg uncertainty principle  
building-up (Aufbau) principle  
principle of equipartition of energy  
Pauli exclusion principle  
absorption process  
adiabatic process  
emission process  
irreversible process  
reversible process  
product of reaction  
ion product constant of water  
proton  
transition element  
symmetry element  
spectral transition  
pyridine  
radical  
induced radioactivity  
spontaneous radioactivity  
bimolecular reaction  
endothermic reaction  
exothermic reaction  
photochemical reaction  
monomolecular (unimolecular) reaction  
first-order reaction  
reduction-oxidation reaction  
kinetically controlled reaction  
thermodynamically controlled reaction  
trimolecular (termolecular) reaction  
reactant  
reduction  
Coulomb repulsion  
rotation  
Clausius-Clapeyron equation  
differential equation  
equation of state for the ideal gas

van der Waals equation  
acid-base equilibrium  
catalytic decomposition  
radioactive decay  
reaction rate  
decay rate  
velocity of light  
reaction order  
orbital scheme  
state scheme  
intermolecular forces  
physical state  
group of elements  
conjugated compound  
nonstoichiometric compound  
electron shell  
closed shell  
solvolysis  
spectrometer  
mass spectrometry  
infrared spectroscopy  
microwave spectroscopy  
electronic spectrum  
rotational spectrum  
vibrational- rotational spectrum  
spin  
elastic collision  
inelastic collision  
reactive collision  
electronic state  
liquid state  
quantum state  
state of a substance  
solid (state)  
gaseous state  
resonance phenomenon  
rotational state  
equilibrium  
singlet state  
stationary state  
standard state  
excited state  
ground state  
stoichiometry  
molecular structure  
centre of symmetry  
degree of degeneracy  
vibrational degree of freedom  
superconductivity  
symmetry  
nuclear fission  
Bohr theory  
quantum theory  
collision theory

heat  
heat of sublimation  
heat of vaporization  
absolute (Kelvin) temperature  
thermodynamics  
chemical thermodynamics  
thiophene  
system trajectory  
tritium  
mass defect  
dihedral angle  
bond angle  
aliphatic hydrocarbon  
alternant hydrocarbon  
cyclic hydrocarbon  
saturated hydrocarbon  
nonalternant hydrocarbon  
unsaturated hydrocarbon  
double bond  
chemical bond  
peptide bond  
triple bond  
hydrogen bond  
vibration  
vibration of a bond  
viscosity  
extensive property  
intensive property  
conductor  
electron shell  
Einstein relation  
weakon  
Hess law  
Lambert-Beer law  
Maxwell-Boltzmann energy-distribution law  
law of conservation of energy  
electromagnetic radiation  
zeolite  
reflection