

CHEMISTRY

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PERIODIC TABLE OF THE ELEMENTS

Labels for the periodic table:
 H — ATOMIC NUMBER
 1.008 — ATOMIC WEIGHT
 H — ATOMIC SYMBOL



ATOMIC STRUCTURE

Atomic Number, Z , is of protons in the nucleus. For neutral atom, $Z = +$ of electrons. For ions of charge, $+Q$, $Z = +Q$ electrons. For ions of charge, $-Q$, $Z = +Q$ electrons. Mass Number, A , is $Z + N$, the number of nucleons in the nucleus. Isotopes atoms with the same Z , different N , the changed sign have a number of protons, say Z , and a different number of neutrons, say N , in their nuclei. Mass Number is Atomic Weight is practical weight used in the lab for a given element.

NUCLEAR CHEMISTRY

Nuclear reactions alter the nucleus, particles emitted or absorbed. Release energy and mass energy. Energy (E) is related to mass (m) using the Einstein equation, $E = mc^2$.
 Number of protons in nucleus, Z , number is symbolized by ${}^A_Z X$, or ${}^A_Z \text{Element}$, Z is $A - N$.
 Types of processes:
 Transmutation: Two elements made from particle collisions.
 Radioactive decay: α -decay, β -decay, γ -decay, e^- , e^+ , p , n , f , fission , fusion .
 Radioactive decay:
 α -decay: He^{4+} , e^- , e^+ , p , n , f , fission , fusion .
 β -decay: e^- , e^+ , p , n , f , fission , fusion .
 γ -decay: γ , p , n , f , fission , fusion .
 e^- , e^+ , p , n , f , fission , fusion .
 p , n , f , fission , fusion .

ATOMIC QUANTUM NUMBERS AND ORBITALS

Quantum numbers: n (principal), l (azimuthal), m_l (magnetic), m_s (spin).
 Orbitals: $1s$, $2s$, $2p$, $3s$, $3p$, $3d$, $4s$, $4p$, $4d$, $4f$, $5s$, $5p$, $5d$, $5f$, $6s$, $6p$, $6d$, $6f$, $7s$, $7p$, $7d$, $7f$, $8s$, $8p$, $8d$, $8f$, $9s$, $9p$, $9d$, $9f$, $10s$, $10p$, $10d$, $10f$, $11s$, $11p$, $11d$, $11f$, $12s$, $12p$, $12d$, $12f$, $13s$, $13p$, $13d$, $13f$, $14s$, $14p$, $14d$, $14f$, $15s$, $15p$, $15d$, $15f$, $16s$, $16p$, $16d$, $16f$, $17s$, $17p$, $17d$, $17f$, $18s$, $18p$, $18d$, $18f$, $19s$, $19p$, $19d$, $19f$, $20s$, $20p$, $20d$, $20f$, $21s$, $21p$, $21d$, $21f$, $22s$, $22p$, $22d$, $22f$, $23s$, $23p$, $23d$, $23f$, $24s$, $24p$, $24d$, $24f$, $25s$, $25p$, $25d$, $25f$, $26s$, $26p$, $26d$, $26f$, $27s$, $27p$, $27d$, $27f$, $28s$, $28p$, $28d$, $28f$, $29s$, $29p$, $29d$, $29f$, $30s$, $30p$, $30d$, $30f$, $31s$, $31p$, $31d$, $31f$, $32s$, $32p$, $32d$, $32f$, $33s$, $33p$, $33d$, $33f$, $34s$, $34p$, $34d$, $34f$, $35s$, $35p$, $35d$, $35f$, $36s$, $36p$, $36d$, $36f$, $37s$, $37p$, $37d$, $37f$, $38s$, $38p$, $38d$, $38f$, $39s$, $39p$, $39d$, $39f$, $40s$, $40p$, $40d$, $40f$, $41s$, $41p$, $41d$, $41f$, $42s$, $42p$, $42d$, $42f$, $43s$, $43p$, $43d$, $43f$, $44s$, $44p$, $44d$, $44f$, $45s$, $45p$, $45d$, $45f$, $46s$, $46p$, $46d$, $46f$, $47s$, $47p$, $47d$, $47f$, $48s$, $48p$, $48d$, $48f$, $49s$, $49p$, $49d$, $49f$, $50s$, $50p$, $50d$, $50f$, $51s$, $51p$, $51d$, $51f$, $52s$, $52p$, $52d$, $52f$, $53s$, $53p$, $53d$, $53f$, $54s$, $54p$, $54d$, $54f$, $55s$, $55p$, $55d$, $55f$, $56s$, $56p$, $56d$, $56f$, $57s$, $57p$, $57d$, $57f$, $58s$, $58p$, $58d$, $58f$, $59s$, $59p$, $59d$, $59f$, $60s$, $60p$, $60d$, $60f$, $61s$, $61p$, $61d$, $61f$, $62s$, $62p$, $62d$, $62f$, $63s$, $63p$, $63d$, $63f$, $64s$, $64p$, $64d$, $64f$, $65s$, $65p$, $65d$, $65f$, $66s$, $66p$, $66d$, $66f$, $67s$, $67p$, $67d$, $67f$, $68s$, $68p$, $68d$, $68f$, $69s$, $69p$, $69d$, $69f$, $70s$, $70p$, $70d$, $70f$, $71s$, $71p$, $71d$, $71f$, $72s$, $72p$, $72d$, $72f$, $73s$, $73p$, $73d$, $73f$, $74s$, $74p$, $74d$, $74f$, $75s$, $75p$, $75d$, $75f$, $76s$, $76p$, $76d$, $76f$, $77s$, $77p$, $77d$, $77f$, $78s$, $78p$, $78d$, $78f$, $79s$, $79p$, $79d$, $79f$, $80s$, $80p$, $80d$, $80f$, $81s$, $81p$, $81d$, $81f$, $82s$, $82p$, $82d$, $82f$, $83s$, $83p$, $83d$, $83f$, $84s$, $84p$, $84d$, $84f$, $85s$, $85p$, $85d$, $85f$, $86s$, $86p$, $86d$, $86f$, $87s$, $87p$, $87d$, $87f$, $88s$, $88p$, $88d$, $88f$, $89s$, $89p$, $89d$, $89f$, $90s$, $90p$, $90d$, $90f$, $91s$, $91p$, $91d$, $91f$, $92s$, $92p$, $92d$, $92f$, $93s$, $93p$, $93d$, $93f$, $94s$, $94p$, $94d$, $94f$, $95s$, $95p$, $95d$, $95f$, $96s$, $96p$, $96d$, $96f$, $97s$, $97p$, $97d$, $97f$, $98s$, $98p$, $98d$, $98f$, $99s$, $99p$, $99d$, $99f$, $100s$, $100p$, $100d$, $100f$.

MANY-ELECTRON ATOMS

Orbitals and quantum numbers: n (principal), l (azimuthal), m_l (magnetic), m_s (spin).
 Aufbau Principle: Electrons fill orbitals from lowest energy to highest energy.
 Hund's Rule: Electrons fill orbitals singly before pairing up.
 Pauli Exclusion Principle: No two electrons can have the same four quantum numbers.

n	l	m _l	m _s	Orbital
1	0	0	$\pm \frac{1}{2}$	1s
2	0	0	$\pm \frac{1}{2}$	2s
2	1	0	$\pm \frac{1}{2}$	2p _z
2	1	± 1	$\pm \frac{1}{2}$	2p _x , 2p _y
3	0	0	$\pm \frac{1}{2}$	3s
3	1	0	$\pm \frac{1}{2}$	3p _z
3	1	± 1	$\pm \frac{1}{2}$	3p _x , 3p _y
3	2	0	$\pm \frac{1}{2}$	3d _{z²}
3	2	± 1	$\pm \frac{1}{2}$	3d _{xy} , 3d _{xz} , 3d _{yz}
3	2	± 2	$\pm \frac{1}{2}$	3d _{x²-y²}
4	0	0	$\pm \frac{1}{2}$	4s
4	1	0	$\pm \frac{1}{2}$	4p _z
4	1	± 1	$\pm \frac{1}{2}$	4p _x , 4p _y
4	2	0	$\pm \frac{1}{2}$	4d _{z²}
4	2	± 1	$\pm \frac{1}{2}$	4d _{xy} , 4d _{xz} , 4d _{yz}
4	2	± 2	$\pm \frac{1}{2}$	4d _{x²-y²}
4	3	0	$\pm \frac{1}{2}$	4f _{z³}
4	3	± 1	$\pm \frac{1}{2}$	4f _{yz²} , 4f _{xz²}
4	3	± 2	$\pm \frac{1}{2}$	4f _{x²-y²} , 4f _{xy²}
4	3	± 3	$\pm \frac{1}{2}$	4f _{xyz}

Atomic configuration: $1s^2 2s^2 2p^6 3s^2 3p^4$.
 Aufbau Principle: Electrons fill orbitals from lowest energy to highest energy.
 Hund's Rule: Electrons fill orbitals singly before pairing up.
 Pauli Exclusion Principle: No two electrons can have the same four quantum numbers.



Element	Symbol	Atomic Number	Group	Period
Hydrogen	H	1	1	1
Helium	He	2	18	1
Lithium	Li	3	1	2
Beryllium	Be	4	2	2
Boron	B	5	13	2
Carbon	C	6	14	2
Nitrogen	N	7	15	2
Oxygen	O	8	16	2
Fluorine	F	9	17	2
Neon	Ne	10	18	2
Sodium	Na	11	1	3
Magnesium	Mg	12	2	3
Aluminum	Al	13	13	3
Silicon	Si	14	14	3
Phosphorus	P	15	15	3
Sulfur	S	16	16	3
Chlorine	Cl	17	17	3
Argon	Ar	18	18	3
Potassium	K	19	1	4
Calcium	Ca	20	2	4
Scandium	Sc	21	3	4
Titanium	Ti	22	4	4
Vanadium	V	23	5	4
Chromium	Cr	24	6	4
Manganese	Mn	25	7	4
Iron	Fe	26	8	4
Cobalt	Co	27	9	4
Nickel	Ni	28	10	4
Copper	Cu	29	11	4
Zinc	Zn	30	12	4
Gallium	Ga	31	13	4
Germanium	Ge	32	14	4
Arsenic	As	33	15	4
Selenium	Se	34	16	4
Bromine	Br	35	17	4
Krypton	Kr	36	18	4
Rubidium	Rb	37	1	5
Strontium	Sr	38	2	5
Yttrium	Y	39	3	5
Zirconium	Zr	40	4	5
Niobium	Nb	41	5	5
Molybdenum	Mo	42	6	5
Technetium	Tc	43	7	5
Ruthenium	Ru	44	8	5
Rhodium	Rh	45	9	5
Palladium	Pd	46	10	5
Silver	Ag	47	11	5
Cadmium	Cd	48	12	5
Indium	In	49	13	5
Tin	Sn	50	14	5
Antimony	Sb	51	15	5
Tellurium	Te	52	16	5
Iodine	I	53	17	5
Xenon	Xe	54	18	5
Cesium	Cs	55	1	6
Barium	Ba	56	2	6
Lanthanum	La	57	3	6
Cerium	Ce	58	4	6
Praseodymium	Pr	59	5	6
Neodymium	Nd	60	6	6
Europium	Eu	63	7	6
Gadolinium	Gd	64	8	6
Terbium	Tb	65	9	6
Dysprosium	Dy	66	10	6
Ytterbium	Yb	70	12	6
Lutetium	Lu	71	13	6
Hafnium	Hf	72	4	6
Tantalum	Ta	73	5	6
Tungsten	W	74	6	6
Rhenium	Rh	75	7	6
Osmium	Os	76	8	6
Iridium	Ir	77	9	6
Platinum	Pt	78	10	6
Gold	Au	79	11	6
Mercury	Hg	80	12	6
Thallium	Tl	81	13	6
Lead	Pb	82	14	6
Bismuth	Bi	83	15	6
Polonium	Po	84	16	6
Astatine	At	85	17	6
Radium	Ra	88	2	7
Actinium	Ac	89	3	7
Thorium	Th	90	4	7
Protactinium	Pa	91	5	7
Uranium	U	92	6	7
N plutonium	Pu	94	7	7
Americium	Am	95	8	7
Curium	Cm	96	9	7
Berkelium	Bk	97	10	7
Californium	Cf	98	11	7
Einsteinium	Es	99	12	7
Fermium	Fm	100	13	7
Mendelevium	Md	101	14	7
Nobelium	Nb	102	15	7
Lanthanum	La	57	3	6
Cerium	Ce	58	4	6
Praseodymium	Pr	59	5	6
Neodymium	Nd	60	6	6
Europium	Eu	63	7	6
Gadolinium	Gd	64	8	6
Terbium	Tb	65	9	6
Dysprosium	Dy	66	10	6
Ytterbium	Yb	70	12	6
Lutetium	Lu	71	13	6
Hafnium	Hf	72	4	6
Tantalum	Ta	73	5	6
Tungsten	W	74	6	6
Rhenium	Rh	75	7	6
Osmium	Os	76	8	6
Iridium	Ir	77	9	6
Platinum	Pt	78	10	6
Gold	Au	79	11	6
Mercury	Hg	80	12	6
Thallium	Tl	81	13	6
Lead	Pb	82	14	6
Bismuth	Bi	83	15	6
Polonium	Po	84	16	6
Astatine	At	85	17	6
Radium	Ra	88	2	7
Actinium	Ac	89	3	7
Thorium	Th	90	4	7
Protactinium	Pa	91	5	7
Uranium	U	92	6	7
N plutonium	Pu	94	7	7
Americium	Am	95	8	7
Curium	Cm	96	9	7
Berkelium	Bk	97	10	7
Californium	Cf	98	11	7
Einsteinium	Es	99	12	7
Fermium	Fm	100	13	7
Mendelevium	Md	101	14	7
Nobelium	Nb	102	15	7

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