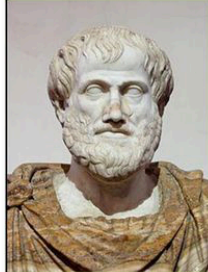
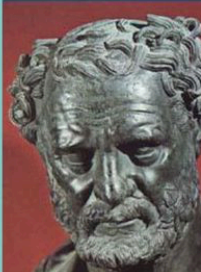


CHEMISTRY UNIT 2 NOTES

Chapter 4 Notes

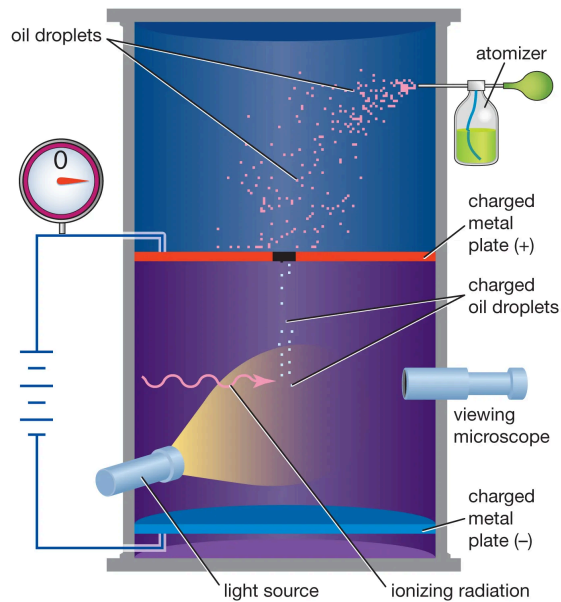
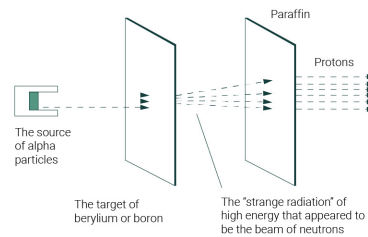
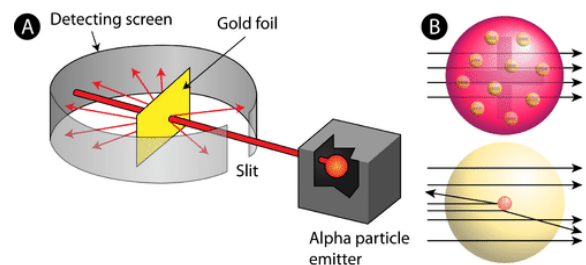
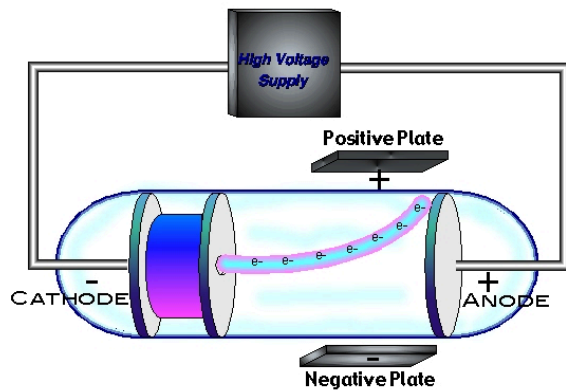
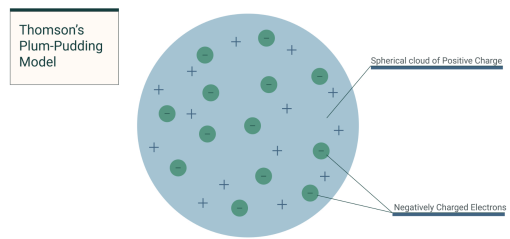
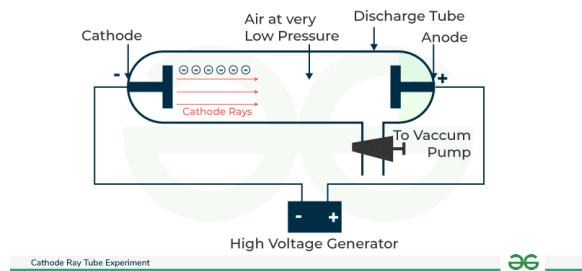
Ancient Greeks

What are all things made of? The debate about the nature of matter!

Aristotle	Democritus (440 BC)
→ Break things apart forever and keep their identity → All things were composed of 4 'elements' (Earth, Air, Fire, Water)	→ Keep breaking in half - eventually get to something that can't be broken down (<i>indivisible particle</i>) → "THE ATOM"
	Democritus was a PHILOSOPHER, not a SCIENTIST. He used <i>reasoning</i>, not <i>experiments</i> to come up with his idea. 

Dalton's Atomic Theory

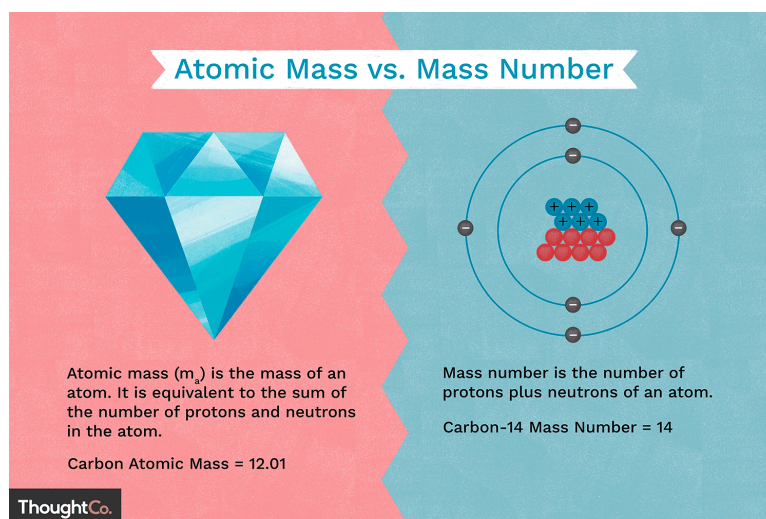
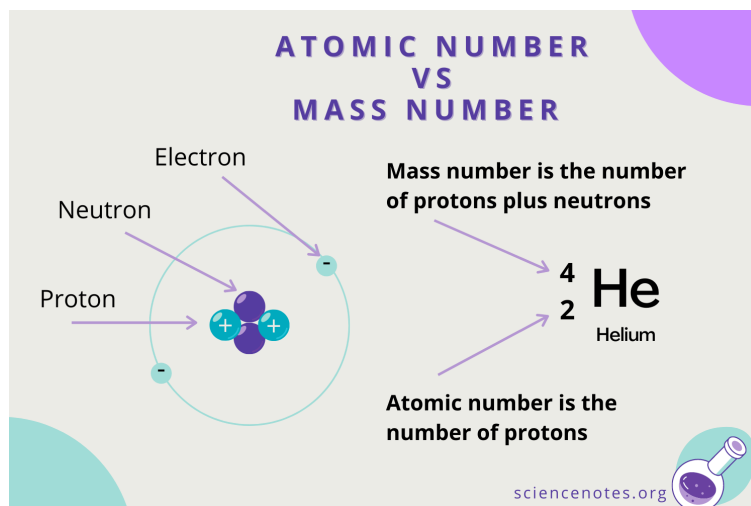
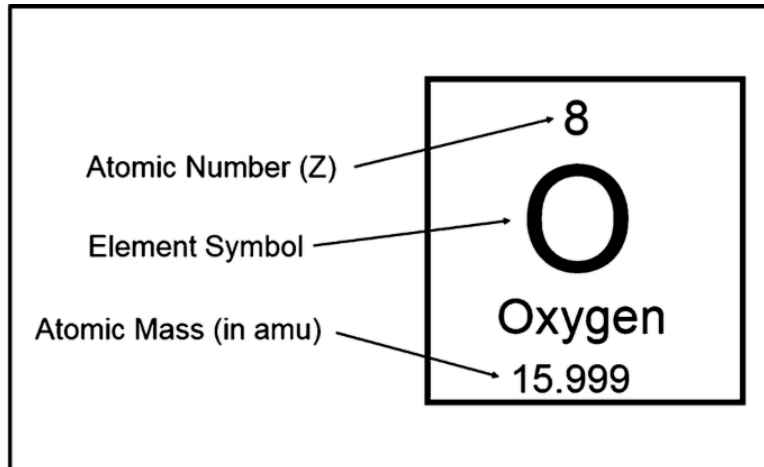
1. Elements are made of tiny particles called atoms.
2. All atoms of a given element are identical.
3. The atoms of a given element are different from those of any other element.
4. Atoms of one element can combine with atoms of other elements to form compounds. A given compound always has the same relative numbers and types of atoms.
5. Atoms are indivisible in chemical processes. That is, atoms are not created or destroyed in chemical reactions. A chemical reaction simply changes the way the atoms are grouped together.



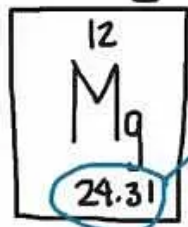
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Subatomic Particle Properties

Particle	Symbol	Location	Charge	Relative Mass (amu)	Actual Mass (g)
electron	e^-	Electron cloud	-	1/1840 approx 0	9.11×10^{-28}
proton	p^+	nucleus	+	1	1.67×10^{-24}
neutron	n^0	nucleus	0	1	1.67×10^{-24}



Calculating average atomic mass

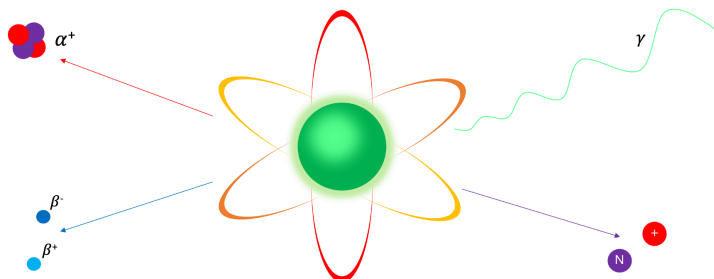


Average atomic mass

Weighted average of masses of all natural isotopes of an element by their abundance.

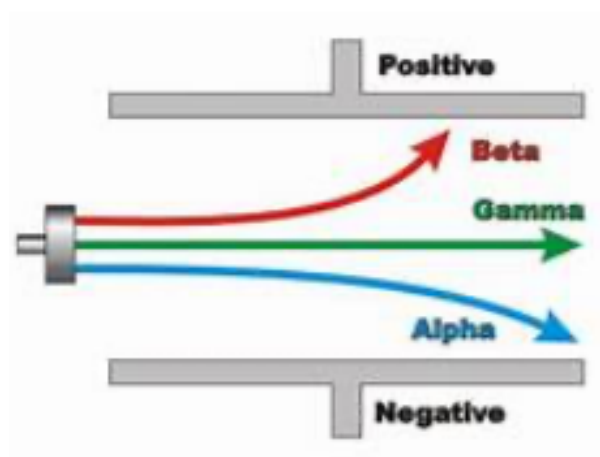
isotope	% abundance	mass	portion of average
Mg-24	78.99	$\times$ 23.98501417	18.94576269
Mg-25	10.00	$\times$ 24.98583692	2.498583692
Mg-26	11.01	$\times$ 25.98259292	2.860683481
			<u>24.30502986</u>

Radioactivity



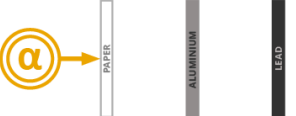
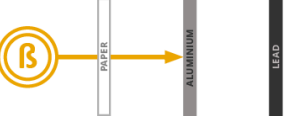
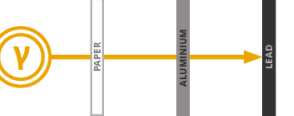
Radiation is energy transmitted in the form of waves or particles. **Light** and **Heat** are forms of radiation.

Radioactive Decay is the **spontaneous** emission of this energy due to nuclear instability.



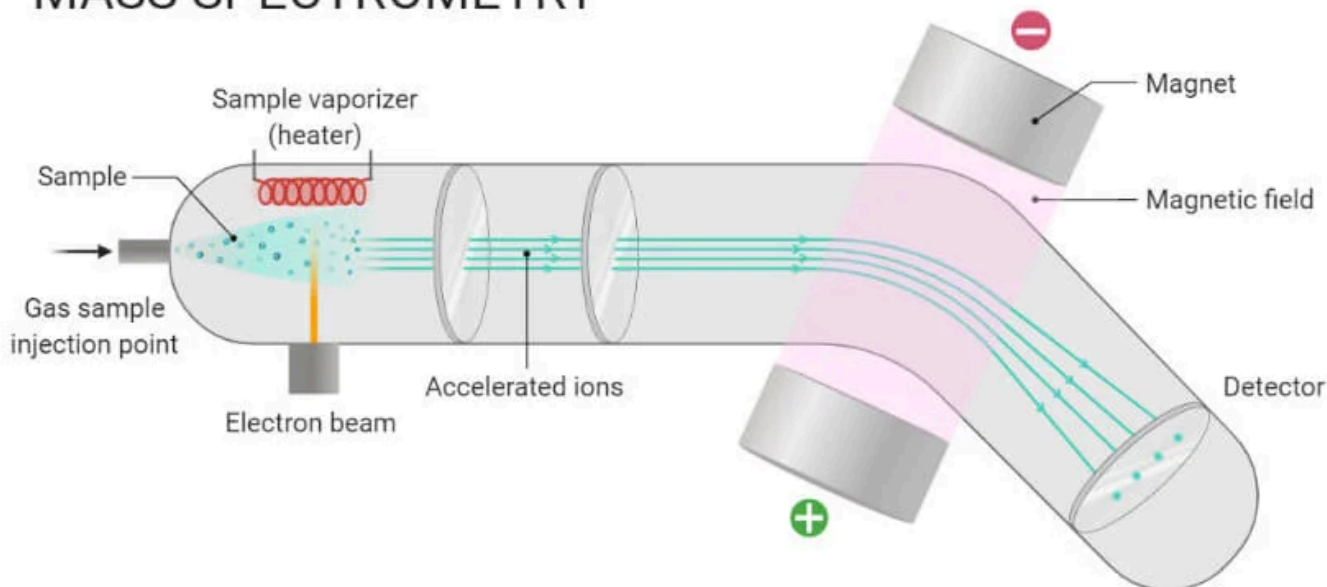
A GUIDE TO DIFFERENT TYPES OF RADIATION

Ionising radiation commonly comes in three different forms: alpha, beta, and gamma radiation. Each of these has a differing composition, and they also differ in their penetration, ionisation ability, and uses. This graphic summarises each type in turn.

 ALPHA 2 protons & 2 neutrons	 BETA High energy electron	 GAMMA High energy EM radiation
IONISATION ABILITY: 	IONISATION ABILITY: 	IONISATION ABILITY: 
HOW PENETRATING? 	HOW PENETRATING? 	HOW PENETRATING? 
		
USES   	USES   	USES   
Many smoke detectors contain americium-241, which releases alpha radiation and helps detect smoke. Alpha radiation-emitting elements have also been used to power some heart pacemakers and some space probes, including the Mars Curiosity Rover.	Beta-radiation emitters can be used as tracers in medicine to image inside the body, and have also been used in cancer treatment. In industry, they have been used to find leaks in underground pipes, and to gauge the thickness of materials during manufacture.	Gamma radiation is used to help sterilise medical equipment, and can also help sterilise packaged foods. Gamma ray detection is used by a number of telescopes to produce images. They have also been used in cancer treatment to help kill cancer cells.

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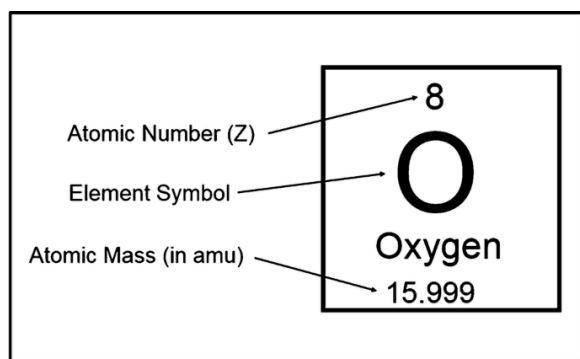
MASS SPECTROMETRY



Chemistry Chapter 5 Notes

Subatomic Particle Properties

Particle	Symbol	Location	Charge	Relative Mass (amu)	Actual Mass (g)
electron	e^-	Electron cloud	$-$	1/1840 approx 0	9.11×10^{-28}
proton	p^+	nucleus	$+$	1	1.67×10^{-24}
neutron	n^0	nucleus	0	1	1.67×10^{-24}



PERIODIC TABLE OF ELEMENTS

Chemical Group Block

Periodic Table of Elements showing chemical groups and blocks. The table includes elements from Hydrogen (H) to Oganesson (Og), with their atomic numbers, symbols, and names. The table is organized into groups (columns) and periods (rows). The lanthanide and actinide series are shown at the bottom of the table.

WHAT DO WE STILL NOT KNOW AT THIS POINT? (EARLY 1900S)

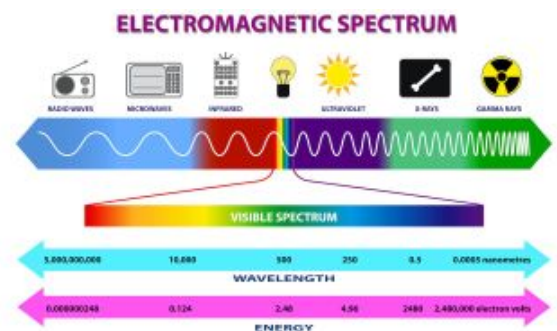
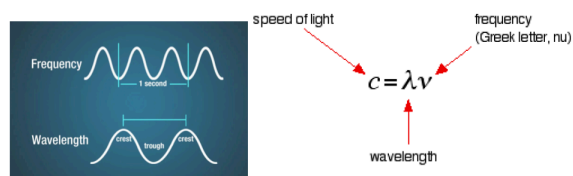
How are electrons arranged in space around the nucleus?

Why are negatively charged electrons not pulled in to positively charged nucleus?

Why do different elements have different chemical behaviors?

Scientists observed that elements emitted visible light when heated in a flame. Analysis revealed that chemical behavior is related to arrangement of electrons.

LET'S TAKE A SIDE TRAIL INTO THE NATURE OF LIGHT...



WHAT DOES LIGHT AS A WAVE NOT EXPLAIN?

1. Why do heated objects emit only certain frequencies of light at a given temperature?
2. Why do some metals emit electrons when light of a specific frequency shines on them?
3. The photoelectric effect- electrons, called photoelectrons, are emitted from a metal's surface when light of a certain frequency shines on it.

PLANCK AND EINSTEIN - WORKING TOGETHER!

Planck concluded: matter can gain or lose energy only in small, specific amounts called **quanta**.

Einstein concluded that light has wave-like and particle-like properties. It's like a **beam of bundles of energy called photons** (which carry a quantum of energy).

• • • Photon Energy

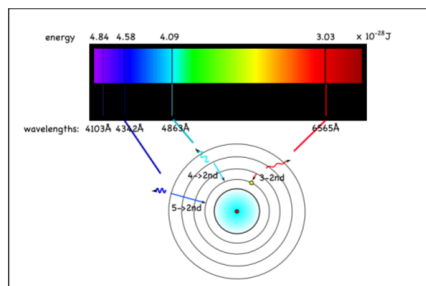
◦ The energy of a photon is given by this equation:

$$E = h\nu$$

• where $h = 6.6262 \times 10^{-34} \text{ J}\cdot\text{s}$
 $\nu = \text{frequency (Hz)}$

ATOMIC EMISSION SPECTRUM - WHY DISCONTINUOUS?

Niels Bohr- certain allowable energy states, and the lowest is **ground state**. When electrons are excited they are in **excited state**. Assigned **quantum numbers** to each orbit. Because only certain energies are possible, only certain frequencies are emitted.



GOOD AND BAD OF BOHR'S MODEL

1. It explained hydrogen's spectral lines, but no other element's.
2. Did not fully account of chemical behavior of atoms.
3. We now believe that electrons do not move around nucleus in circular orbits.

ENTER DE BROGLIE

- 1. Quantized orbits had characteristics similar to waves.
- 2. Could electrons have both particle and wave like characteristics?

De Broglie's Equation

$$\lambda = \frac{h}{mv}$$

Where

λ = wavelength in meters

v = the velocity in meters/sec

m = the mass in kilograms

h = Planck's constant in J/Hz

Heisenberg Uncertainty Principle



"One cannot simultaneously determine both the position and momentum of an electron."

The more certain you are about where the electron is, the less certain you can be about where it is going.

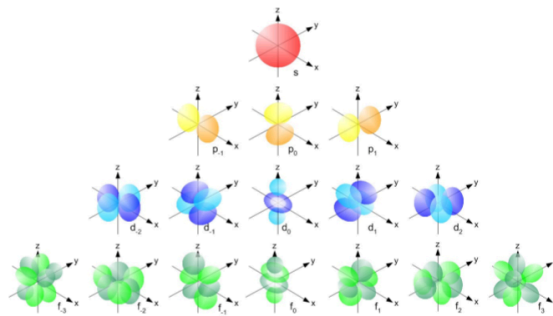
The more certain you are about where the electron is going, the less certain you can be about where it is.

Werner Heisenberg

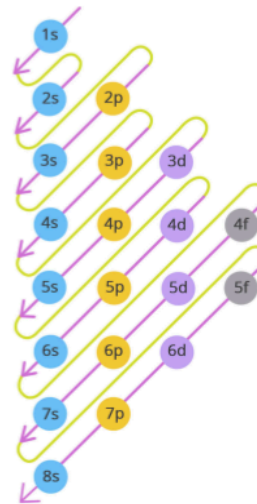
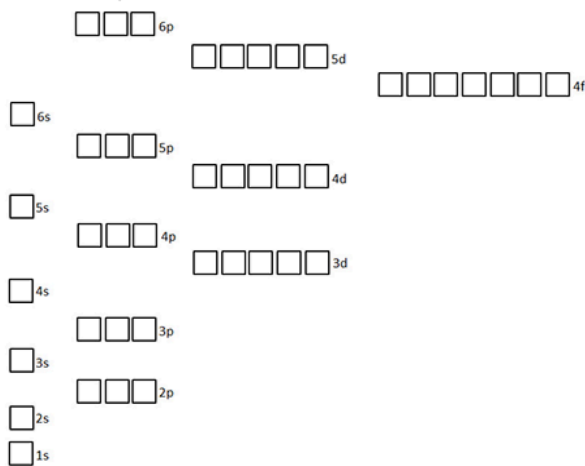
SCHROEDINGER'S QUANTUM MECHANICAL MODEL OF ATOM

1. Electrons are treated as waves.
2. Limits electrons to certain energy values.
3. Does not try to describe the electron's path.
4. Establishes idea of atomic orbital which is the electron's probably location.
5. Works for all elements.
6. 4 principle quantum numbers or principal energy levels indicating relative size and energy of atomic orbitals with their own energy sublevels.

SHAPES OF ORBITALS



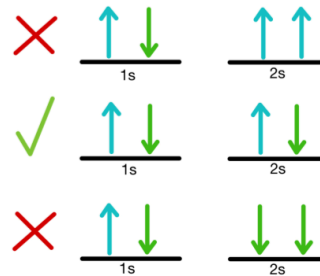
ELECTRON CONFIGURATION: ARRANGEMENTS OF ELECTRONS IN AN ATOM



Aufbau principle:
each electron occupies the lowest energy orbital available.

ELECTRON CONFIGURATION: ARRANGEMENTS OF ELECTRONS IN AN ATOM

Pauli exclusion principle:
a maximum of two electrons can occupy a single atomic orbital, but only if the electrons have opposite spins.

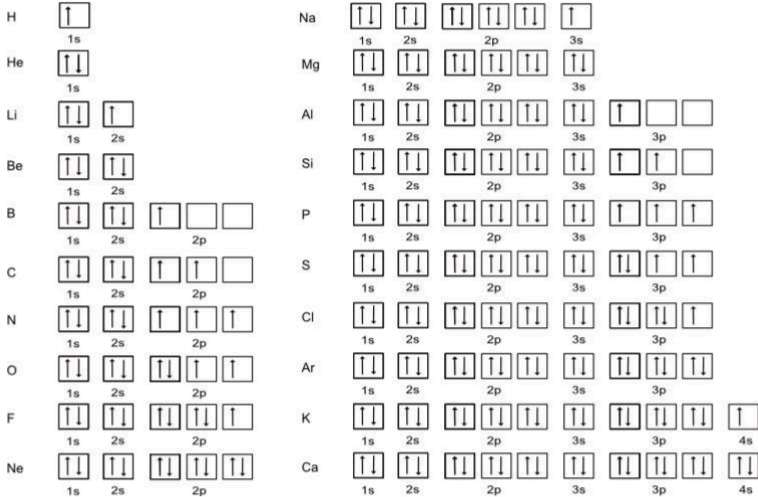


ATOM

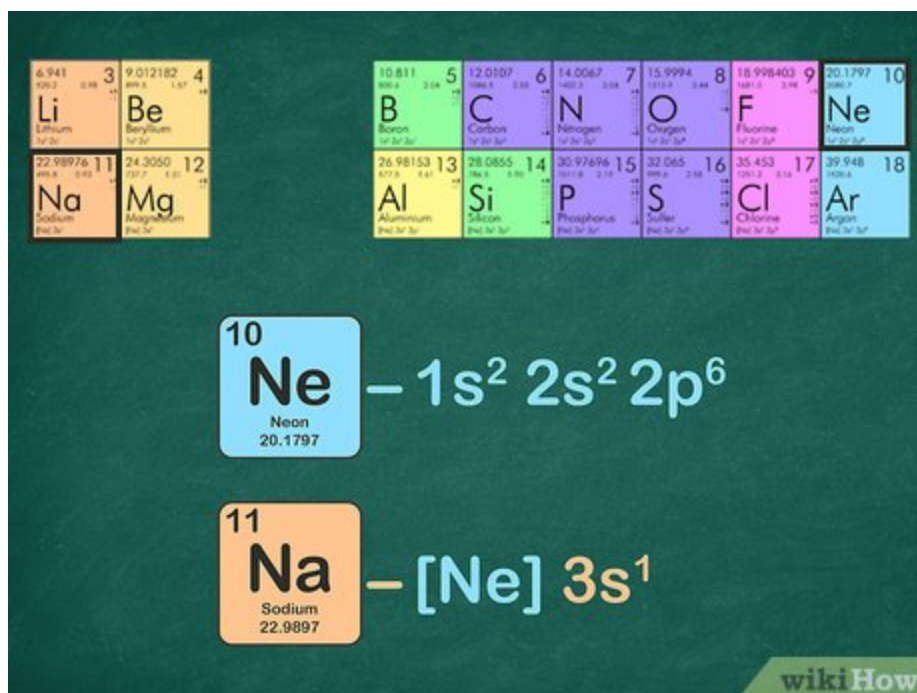
sciencenotes.org

The diagrams illustrate the correct and incorrect ways to fill atomic orbitals with electrons. Each orbital is represented by a box containing one or two arrows (up and down) indicating electron spin.

- Correct Filling (Green Checkmark):**
 - 1s orbital: Two electrons (up and down arrows).
 - 2s orbital: Two electrons (up and down arrows).
 - 2p orbitals: Three electrons, each in a separate orbital (up, up, up arrows).
- Incorrect Filling (Red X):**
 - Diagram 1: 1s orbital has two electrons (up and down arrows), 2s orbital has two electrons (up and down arrows), and the 2p orbitals have two electrons (up and down arrows) with one empty orbital. This is incorrect because the third 2p orbital is empty while the first two are occupied.
 - Diagram 2: 1s orbital has two electrons (up and down arrows), 2s orbital has two electrons (up and down arrows), and the 2p orbitals have three electrons (up, down, up arrows). This is incorrect because the second 2p orbital has a pair of electrons while the first and third are singly occupied.



Element	Electron Configuration	Element	Electron Configuration
H	1s ¹	Na	1s ² 2s ² 2p ⁶ 3s ¹
He	1s ²	Mg	1s ² 2s ² 2p ⁶ 3s ²
Li	1s ² 2s ¹	Al	1s ² 2s ² 2p ⁶ 3s ² 3p ¹
Be	1s ² 2s ²	Si	1s ² 2s ² 2p ⁶ 3s ² 3p ²
B	1s ² 2s ² 2p ¹	P	1s ² 2s ² 2p ⁶ 3s ² 3p ³
C	1s ² 2s ² 2p ²	S	1s ² 2s ² 2p ⁶ 3s ² 3p ⁴
N	1s ² 2s ² 2p ³	Cl	1s ² 2s ² 2p ⁶ 3s ² 3p ⁵
O	1s ² 2s ² 2p ⁴	Ar	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶
F	1s ² 2s ² 2p ⁵	K	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 4s ¹
Ne	1s ² 2s ² 2p ⁶	Ca	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 4s ²



Atoms	Electronic Configuration	Lewis Symbol
sodium	$[\text{Ne}]3s^1$	Na •
magnesium	$[\text{Ne}]3s^2$	•Mg•
aluminum	$[\text{Ne}]3s^23p^1$	•Al•
silicon	$[\text{Ne}]3s^23p^2$	•Si•
phosphorus	$[\text{Ne}]3s^23p^3$	•P•
sulfur	$[\text{Ne}]3s^23p^4$	:S•
chlorine	$[\text{Ne}]3s^23p^5$	:Cl•
argon	$[\text{Ne}]3s^23p^6$	:Ar:

Valence Electrons- electrons in the atom's outermost orbitals

Chemistry Chapter 6 Notes

Development of Periodic Table

Periodic Law- that there is a periodic repetition of chemical and physical properties of the elements when they are arranged in increasing atomic mass

People	Contribution to Periodic Table
Lavoisier	Classified 33 elements in 4 categories: gases, metals, nonmetals, earth
Newlands	Arranged elements by increasing atomic mass, noticed repetition every 8th element
Meyer	Arranged elements by increasing atomic mass, noticed connection between atomic mass and properties
Mendeleev	Arranged elements by increasing atomic mass, noticed connection between atomic mass and properties, and predicted existence and properties of undiscovered elements
Moseley	Discovered atoms contain unique number of protons (atomic number), and arranged elements in order of increasing atomic number rather than mass

PERIODIC TABLE OF ELEMENTS

Chemical Group Block

PubChem

Atomic Number 17 35.45 Atomic Mass, u

Name Symbol Chemical Group Block

Chlorine Halogen

Red- **alkali metals**

Purple- **alkaline earth metals**

Light blue- **lanthanide series** (part of inner transition metals)

Sea Green- **actinide series** (part of inner transition metals)

Blue- **transition metals**

Brown Green- **metalloids**

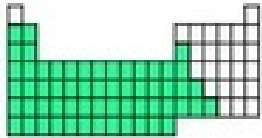
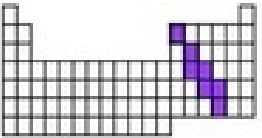
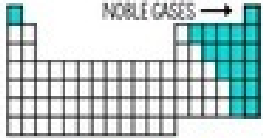
Group 17- **halogens**

Orange- **noble gases**

Yellow- **nonmetals**

Representative elements- elements in groups 1, 2, 13-18

Transition elements- elements in groups 3-12

METALS	METALLOIDS	NONMETALS
- SOLIDS - DUCTILE - METALLIC LUSTER - MALLEABLE - GOOD CONDUCTORS	- PROPERTIES OF BOTH METALS & NONMETALS - METALLIC LUSTER - BRITTLE - SEMICONDUCTORS	- CAN BE SOLID, LIQUID OR GAS - DULL - BRITTLE - INSULATORS
 EXAMPLES: 	 EXAMPLES: 	 EXAMPLES: 
VOCABULARY - BRITTLE: CAN EASILY BREAK - MALLEABLE: CAN BEND WITHOUT BREAKING - DUCTILE: CAN BE MADE INTO THIN WIRES - METALLIC LUSTER: SHINY & REFLECTIVE APPEARANCE - CONDUCTIVITY: ABILITY TO TRANSFER HEAT OR ELECTRICITY		

PERIODIC TABLE OF ELEMENTS

Chemical Group Block

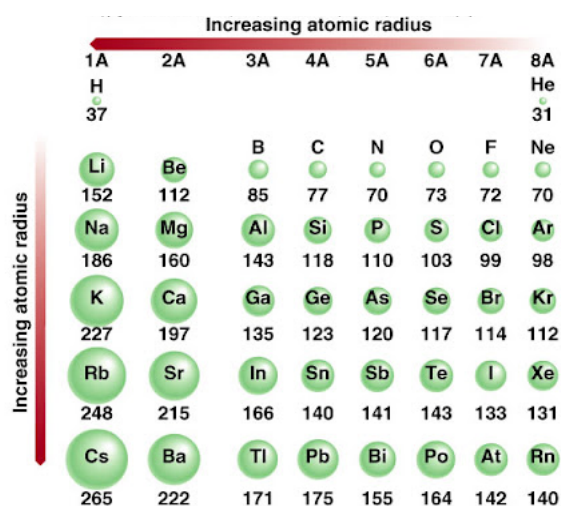
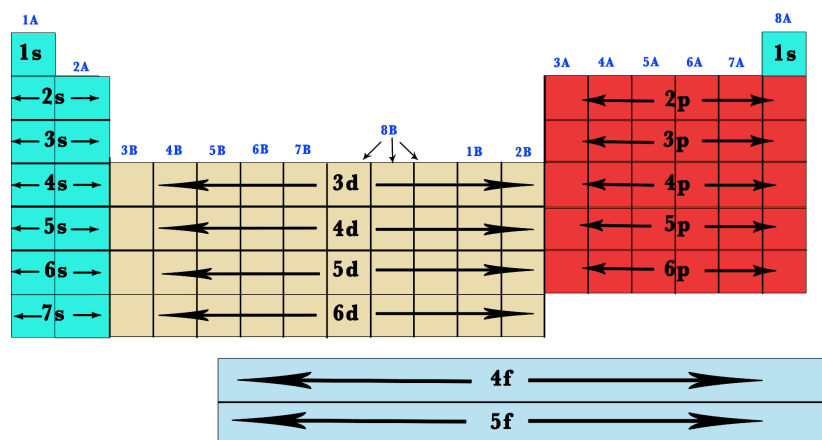
1 H 1.008																18 He 4.0026																			
3 Li 6.941		4 Be 9.0122														10 B 10.811		11 C 12.011		12 N 14.007		13 O 15.999		14 F 18.998		15 Ne 20.180									
19 Na 22.990		20 Mg 24.305														31 Al 26.982		32 Si 28.086		33 P 30.974		34 S 32.06		35 Cl 35.45		36 Ar 39.948									
Atomic Number 17 35.45 Atomic Mass, u																PubChem																			
Name Chlorine halogen																Symbol Cl Chemical Group Block																			
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000																																			
19 K 39.098		20 Ca 40.078		21 Sc 44.956		22 Ti 47.88		23 V 50.942		24 Cr 51.996		25 Mn 54.938		26 Fe 55.845		27 Co 58.933		28 Ni 58.69		29 Cu 63.546		30 Zn 65.38		31 Ga 69.723		32 Ge 72.64		33 As 74.922		34 Se 78.96		35 Br 79.904		36 Kr 83.80	
37 Rb 85.468		38 Sr 87.62		39 Y 88.906		40 Zr 91.224		41 Nb 92.906		42 Mo 95.94		43 Tc 98.906		44 Ru 101.07		45 Rh 102.91		46 Pd 106.42		47 Ag 107.868		48 Cd 112.411		49 In 114.818		50 Sn 118.710		51 Sb 121.757		52 Te 127.6		53 I 126.905		54 Xe 131.29	
55 Cs 132.905		56 Ba 137.327		57 La 138.905		58 Ce 140.12		59 Pr 140.908		60 Nd 144.24		61 Pm 144.913		62 Sm 150.36		63 Eu 151.964		64 Gd 157.25		65 Tb 158.925		66 Dy 162.50		67 Ho 164.930		68 Er 167.259		69 Tm 168.933		70 Yb 173.054		71 Lu 174.967			
87 Fr 223.021		88 Ra 226.025		89 Ac 227.033		90 Th 232.0377		91 Pa 231.036		92 U 238.02891		93 Np 237.04817		94 Pu 244.06422		95 Am 243.06138		96 Cm 247.07715		97 Bk 247.07129		98 Cf 251.0834		99 Es 252.083		100 Fm 257.10		101 Md 258.10		102 No 259.10		103 Lr 262.10			

Atoms in the same group have similar chemical properties because they have the same number of valence electrons. The energy level of an element's valence electrons indicates the period on the periodic table in which it is found.

I	II							III	IV	V	VI	VII	0
H •													He ••
Li •	Be ••							B ••	C •••	N ••••	O ••••	F •••••	Ne ••••••
Na •	Mg ••							Al ••	Si •••	P ••••	S •••••	Cl ••••••	Ar •••••••
K •	Ca ••							Ga ••	Ge •••	As ••••	Se •••••	Br ••••••	Kr •••••••
Rb •	Sr ••							In ••	Sn •••	Sb ••••	Te •••••	I ••••••	Xe •••••••
Cs •	Ba ••							Tl ••	Pb •••	Bi ••••	Po •••••	At ••••••	Rn •••••••

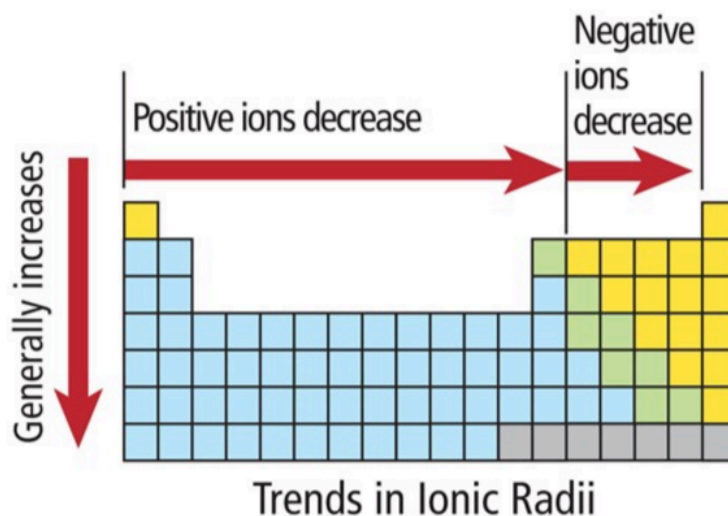
	Metal		Metallloid		Nonmetal
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s,p,d,f blocks in the periodic table.

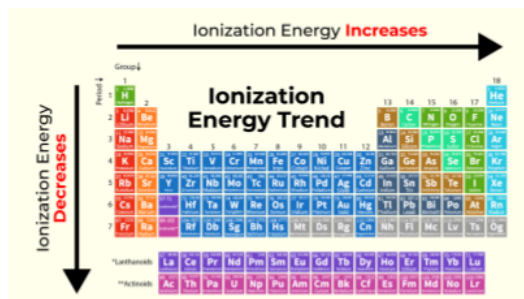
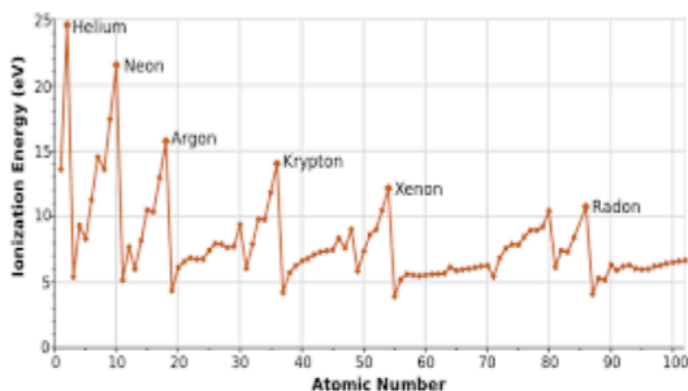


IONIC RADIUS TREND- WE WILL REVISIT THIS IN A LATER UNIT!

An ion is an atom or a bonded group of atoms that has a positive or negative charge



IONIZATION ENERGY- THE ENERGY REQUIRED TO REMOVE AN ELECTRON FROM A GASEOUS ATOM. HOW STRONGLY AN ATOM'S NUCLEUS HOLDS ONTO ITS VALENCE ELECTRONS.



OCTET RULE

Atoms tend to gain, lose, or share electrons in order to acquire a full set of 8 valence electrons.

Elements on left tend to lose electrons and form positive ions. Elements on right tend to gain electrons and form negative ions.

Electronegativity values of the elements in the periodic table

Each element has an electronegativity value, which is a measure of the ability of an atom to attract and share electron pairs of another atom.

————— increasing electronegativity —————→

																	13	14	15	16	17	18	
group	1																						
	H																	B	C	N	O	F	Ne
	2.2																	2.0	2.6	3.0	3.4	4.0	—
	Li	Be															Al	Si	P	S	Cl	Ar	
	1.0	1.6															1.6	1.9	2.2	2.6	3.2	—	
	Na	Mg																					
	0.9	1.3																					
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr					
	0.8	1.0	1.4	1.5	1.6	1.7	1.6	1.8	1.9	1.9	1.9	1.7	1.8	2.0	2.2	2.6	3.0	3.0					
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe					
	0.8	1.0	1.2	1.3	1.6	2.2	1.9	2.2	2.3	2.2	1.9	1.7	1.8	2.0	2.1	2.1	2.7	2.6					
	Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn					
	0.8	0.9	1.1-1.3	1.3	1.5	2.4	1.9	2.2	2.2	2.3	2.5	2.0	1.6	2.3	2.0	2.0	2.2	—					
	Fr	Ra	Ac-Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og					
	0.7	0.9	1.1-1.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—					

↓ decreasing electronegativity

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