

# **Reference Sheets for Unit #4 – Periodic Table**



# Periodic Table Structure Info Sheet

**Periods (rows) →**

**Mendeleev** – Organized PT based on atomic masses & properties (almost right...)

**Groups (columns) ↑**

**Moseley** – Organized PT based on atomic numbers (the way we do it now!)

**Three classes of elements:** Metals, non-metals, metalloids/semi-metals

|                       |  |                                   |  |                                       |  |                                      |  |                                      |  |                                       |  |                                 |  |                                      |  |                                        |  |                                          |  |                                       |  |                                          |  |                                         |  |                                          |  |                                        |  |                                    |  |                                       |  |                                      |  |                                    |  |                                    |  |                                    |  |                                    |  |                                    |  |                                    |  |      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| Period 1<br>1 H 1.008 |  | Period 2<br>3 Li 6.941 4 Be 9.012 |  | Period 3<br>11 Na 22.990 12 Mg 24.305 |  | Period 4<br>19 K 39.098 20 Ca 40.078 |  | Period 5<br>37 Rb 85.468 38 Sr 87.62 |  | Period 6<br>55 Cs 132.91 56 Ba 137.33 |  | Period 7<br>87 Fr 223 88 Ra 226 |  | Period 8<br>101 Lu 175 102 Hf 178.49 |  | Period 9<br>103 Ta 180.95 104 W 183.84 |  | Period 10<br>105 Re 186.21 106 Os 190.23 |  | Period 11<br>107 Ir 222 108 Pt 200.26 |  | Period 12<br>109 Au 196.97 110 Hg 200.59 |  | Period 13<br>111 Tl 204.38 112 Pb 207.2 |  | Period 14<br>113 Sn 118.71 114 Sb 121.76 |  | Period 15<br>115 Te 127.6 116 I 126.90 |  | Period 16<br>117 At 210 118 Rn 222 |  | Period 17<br>119 Ac 227 120 Th 232.04 |  | Period 18<br>121 Pa 231 122 U 238.03 |  | Period 19<br>123 Np 237 124 Pu 244 |  | Period 20<br>125 Am 243 126 Cm 247 |  | Period 21<br>127 Bk 247 128 Cf 251 |  | Period 22<br>129 Es 252 130 Fm 257 |  | Period 23<br>131 Md 258 132 No 259 |  | Period 24<br>133 Lr 262 134 Rf 261 |  | Period 25<br>135 Db 262 136 Sg 266 |  | Period 26<br>137 Bh 264 138 Hs 277 |  | Period 27<br>139 Mt 268 140 Ds 271 |  | Period 28<br>141 Rg 272 142 Og 284 |  | Period 29<br>143 Uu 286 144 Uub 289 |  | Period 30<br>145 Uut 288 146 Uuq 291 |  | Period 31<br>147 Uuh 292 148 Uus 295 |  | Period 32<br>149 Uuq 296 150 Uub 299 |  | Period 33<br>151 Uuq 300 152 Uub 303 |  | Period 34<br>153 Uuq 302 154 Uub 305 |  | Period 35<br>155 Uuq 304 156 Uub 307 |  | Period 36<br>157 Uuq 306 158 Uub 309 |  | Period 37<br>159 Uuq 308 160 Uub 311 |  | Period 38<br>161 Uuq 310 162 Uub 313 |  | Period 39<br>163 Uuq 312 164 Uub 315 |  | Period 40<br>165 Uuq 314 166 Uub 317 |  | Period 41<br>167 Uuq 316 168 Uub 319 |  | Period 42<br>169 Uuq 318 170 Uub 321 |  | Period 43<br>171 Uuq 320 172 Uub 323 |  | Period 44<br>173 Uuq 322 174 Uub 325 |  | Period 45<br>175 Uuq 324 176 Uub 327 |  | Period 46<br>177 Uuq 326 178 Uub 329 |  | Period 47<br>179 Uuq 328 180 Uub 331 |  | Period 48<br>181 Uuq 330 182 Uub 333 |  | Period 49<br>183 Uuq 332 184 Uub 335 |  | Period 50<br>185 Uuq 334 186 Uub 337 |  | Period 51<br>187 Uuq 336 188 Uub 339 |  | Period 52<br>189 Uuq 338 190 Uub 341 |  | Period 53<br>191 Uuq 340 192 Uub 343 |  | Period 54<br>193 Uuq 342 194 Uub 345 |  | Period 55<br>195 Uuq 344 196 Uub 347 |  | Period 56<br>197 Uuq 346 198 Uub 349 |  | Period 57<br>199 Uuq 348 200 Uub 351 |  | Period 58<br>201 Uuq 350 202 Uub 353 |  | Period 59<br>203 Uuq 352 204 Uub 355 |  | Period 60<br>205 Uuq 354 206 Uub 357 |  | Period 61<br>207 Uuq 356 208 Uub 359 |  | Period 62<br>209 Uuq 358 210 Uub 361 |  | Period 63<br>211 Uuq 360 212 Uub 363 |  | Period 64<br>213 Uuq 362 214 Uub 365 |  | Period 65<br>215 Uuq 364 216 Uub 367 |  | Period 66<br>217 Uuq 366 218 Uub 369 |  | Period 67<br>219 Uuq 368 220 Uub 371 |  | Period 68<br>221 Uuq 370 222 Uub 373 |  | Period 69<br>223 Uuq 372 224 Uub 375 |  | Period 70<br>225 Uuq 374 226 Uub 377 |  | Period 71<br>227 Uuq 376 228 Uub 379 |  | Period 72<br>229 Uuq 378 230 Uub 381 |  | Period 73<br>231 Uuq 380 232 Uub 383 |  | Period 74<br>233 Uuq 382 234 Uub 385 |  | Period 75<br>235 Uuq 384 236 Uub 387 |  | Period 76<br>237 Uuq 386 238 Uub 389 |  | Period 77<br>239 Uuq 388 240 Uub 391 |  | Period 78<br>241 Uuq 390 242 Uub 393 |  | Period 79<br>243 Uuq 392 244 Uub 395 |  | Period 80<br>245 Uuq 394 246 Uub 397 |  | Period 81<br>247 Uuq 396 248 Uub 399 |  | Period 82<br>249 Uuq 398 250 Uub 401 |  | Period 83<br>251 Uuq 400 252 Uub 403 |  | Period 84<br>253 Uuq 402 254 Uub 405 |  | Period 85<br>255 Uuq 404 256 Uub 407 |  | Period 86<br>257 Uuq 406 258 Uub 409 |  | Period 87<br>259 Uuq 408 260 Uub 411 |  | Period 88<br>261 Uuq 410 262 Uub 413 |  | Period 89<br>263 Uuq 412 264 Uub 415 |  | Period 90<br>265 Uuq 414 266 Uub 417 |  | Period 91<br>267 Uuq 416 268 Uub 419 |  | Period 92<br>269 Uuq 418 270 Uub 421 |  | Period 93<br>271 Uuq 420 272 Uub 423 |  | Period 94<br>273 Uuq 422 274 Uub 425 |  | Period 95<br>275 Uuq 424 276 Uub 427 |  | Period 96<br>277 Uuq 426 278 Uub 429 |  | Period 97<br>279 Uuq 428 280 Uub 431 |  | Period 98<br>281 Uuq 430 282 Uub 433 |  | Period 99<br>283 Uuq 432 284 Uub 435 |  | Period 100<br>285 Uuq 434 286 Uub 437 |  | Period 101<br>287 Uuq 436 288 Uub 439 |  | Period 102<br>289 Uuq 438 290 Uub 441 |  | Period 103<br>291 Uuq 440 292 Uub 443 |  | Period 104<br>293 Uuq 442 294 Uub 445 |  | Period 105<br>295 Uuq 444 296 Uub 447 |  | Period 106<br>297 Uuq 446 298 Uub 449 |  | Period 107<br>299 Uuq 448 300 Uub 451 |  | Period 108<br>301 Uuq 450 302 Uub 453 |  | Period 109<br>303 Uuq 452 304 Uub 455 |  | Period 110<br>305 Uuq 454 306 Uub 457 |  | Period 111<br>307 Uuq 456 308 Uub 459 |  | Period 112<br>309 Uuq 458 310 Uub 461 |  | Period 113<br>311 Uuq 460 312 Uub 463 |  | Period 114<br>313 Uuq 462 314 Uub 465 |  | Period 115<br>315 Uuq 464 316 Uub 467 |  | Period 116<br>317 Uuq 466 318 Uub 469 |  | Period 117<br>319 Uuq 468 320 Uub 471 |  | Period 118<br>321 Uuq 470 322 Uub 473 |  | Period 119<br>323 Uuq 472 324 Uub 475 |  | Period 120<br>325 Uuq 474 326 Uub 477 |  | Period 121<br>327 Uuq 476 328 Uub 479 |  | Period 122<br>329 Uuq 478 330 Uub 481 |  | Period 123<br>331 Uuq 480 332 Uub 483 |  | Period 124<br>333 Uuq 482 334 Uub 485 |  | Period 125<br>335 Uuq 484 336 Uub 487 |  | Period 126<br>337 Uuq 486 338 Uub 489 |  | Period 127<br>339 Uuq 488 340 Uub 491 |  | Period 128<br>341 Uuq 490 342 Uub 493 |  | Period 129<br>343 Uuq 492 344 Uub 495 |  | Period 130<br>345 Uuq 494 346 Uub 497 |  | Period 131<br>347 Uuq 496 348 Uub 499 |  | Period 132<br>349 Uuq 498 350 Uub 501 |  | Period 133<br>351 Uuq 500 352 Uub 503 |  | Period 134<br>353 Uuq 502 354 Uub 505 |  | Period 135<br>355 Uuq 504 356 Uub 507 |  | Period 136<br>357 Uuq 506 358 Uub 509 |  | Period 137<br>359 Uuq 508 360 Uub 511 |  | Period 138<br>361 Uuq 510 362 Uub 513 |  | Period 139<br>363 Uuq 512 364 Uub 515 |  | Period 140<br>365 Uuq 514 366 Uub 517 |  | Period 141<br>367 Uuq 516 368 Uub 519 |  | Period 142<br>369 Uuq 518 370 Uub 521 |  | Period 143<br>371 Uuq 520 372 Uub 523 |  | Period 144<br>373 Uuq 522 374 Uub 525 |  | Period 145<br>375 Uuq 524 376 Uub 527 |  | Period 146<br>377 Uuq 526 378 Uub 529 |  | Period 147<br>379 Uuq 528 380 Uub 531 |  | Period 148<br>381 Uuq 530 382 Uub 533 |  | Period 149<br>383 Uuq 532 384 Uub 535 |  | Period 150<br>385 Uuq 534 386 Uub 537 |  | Period 151<br>387 Uuq 536 388 Uub 539 |  | Period 152<br>389 Uuq 538 390 Uub 541 |  | Period 153<br>391 Uuq 540 392 Uub 543 |  | Period 154<br>393 Uuq 542 394 Uub 545 |  | Period 155<br>395 Uuq 544 396 Uub 547 |  | Period 156<br>397 Uuq 546 398 Uub 549 |  | Period 157<br>399 Uuq 548 400 Uub 551 |  | Period 158<br>401 Uuq 550 402 Uub 553 |  | Period 159<br>403 Uuq 552 404 Uub 555 |  | Period 160<br>405 Uuq 554 406 Uub 557 |  | Period 161<br>407 Uuq 556 408 Uub 559 |  | Period 162<br>409 Uuq 558 410 Uub 561 |  | Period 163<br>411 Uuq 560 412 Uub 563 |  | Period 164<br>413 Uuq 562 414 Uub 565 |  | Period 165<br>415 Uuq 564 416 Uub 567 |  | Period 166<br>417 Uuq 566 418 Uub 569 |  | Period 167<br>419 Uuq 568 420 Uub 571 |  | Period 168<br>421 Uuq 570 422 Uub 573 |  | Period 169<br>423 Uuq 572 424 Uub 575 |  | Period 170<br>425 Uuq 574 426 Uub 577 |  | Period 171<br>427 Uuq 576 428 Uub 579 |  | Period 172<br>429 Uuq 578 430 Uub 581 |  | Period 173<br>431 Uuq 580 432 Uub 583 |  | Period 174<br>433 Uuq 582 434 Uub 585 |  | Period 175<br>435 Uuq 584 436 Uub 587 |  | Period 176<br>437 Uuq 586 438 Uub 589 |  | Period 177<br>439 Uuq 588 440 Uub 591 |  | Period 178<br>441 Uuq 590 442 Uub 593 |  | Period 179<br>443 Uuq 592 444 Uub 595 |  | Period 180<br>445 Uuq 594 446 Uub 597 |  | Period 181<br>447 Uuq 596 448 Uub 599 |  | Period 182<br>449 Uuq 598 450 Uub 601 |  | Period 183<br>451 Uuq 600 452 Uub 603 |  | Period 184<br>453 Uuq 602 454 Uub 605 |  | Period 185<br>455 Uuq 604 456 Uub 607 |  | Period 186<br>457 Uuq 606 458 Uub 609 |  | Period 187<br>459 Uuq 608 460 Uub 611 |  | Period 188<br>461 Uuq 610 462 Uub 613 |  | Period 189<br>463 Uuq 612 464 Uub 615 |  | Period 190<br>465 Uuq 614 466 Uub 617 |  | Period 191<br>467 Uuq 616 468 Uub 619 |  | Period 192<br>469 Uuq 618 470 Uub 621 |  | Period 193<br>471 Uuq 620 472 Uub 623 |  | Period 194<br>473 Uuq 622 474 Uub 625 |  | Period 195<br>475 Uuq 624 476 Uub 627 |  | Period 196<br>477 Uuq 626 478 Uub 629 |  | Period 197<br>479 Uuq 628 480 Uub 631 |  | Period 198<br>481 Uuq 630 482 Uub 633 |  | Period 199<br>483 Uuq 632 484 Uub 635 |  | Period 200<br>485 Uuq 634 486 Uub 637 |  | Period 201<br>487 Uuq 636 488 Uub 639 |  | Period 202<br>489 Uuq 638 490 Uub 641 |  | Period 203<br>491 Uuq 640 492 Uub 643 |  | Period 204<br>493 Uuq 642 494 Uub 645 |  | Period 205<br>495 Uuq 644 496 Uub 647 |  | Period 206<br>497 Uuq 646 498 Uub 649 |  | Period 207<br>499 Uuq 648 500 Uub 651 |  | Period 208<br>501 Uuq 650 502 Uub 653 |  | Period 209<br>503 Uuq 652 504 Uub 655 |  | Period 210<br>505 Uuq 654 506 Uub 657 |  | Period 211<br>507 Uuq 656 508 Uub 659 |  | Period 212<br>509 Uuq 658 510 Uub 661 |  | Period 213<br>511 Uuq 660 512 Uub 663 |  | Period 214<br>513 Uuq 662 514 Uub 665 |  | Period 215<br>515 Uuq 664 516 Uub 667 |  | Period 216<br>517 Uuq 666 518 Uub 669 |  | Period 217<br>519 Uuq 668 520 Uub 671 |  | Period 218<br>521 Uuq 670 522 Uub 673 |  | Period 219<br>523 Uuq 672 524 Uub 675 |  | Period 220<br>525 Uuq 674 526 Uub 677 |  | Period 221<br>527 Uuq 676 528 Uub 679 |  | Period 222<br>529 Uuq 678 530 Uub 681 |  | Period 223<br>531 Uuq 680 532 Uub 683 |  | Period 224<br>533 Uuq 682 534 Uub 685 |  | Period 225<br>535 Uuq 684 536 Uub 687 |  | Period 226<br>537 Uuq 686 538 Uub 689 |  | Period 227<br>539 Uuq 688 540 Uub 691 |  | Period 228<br>541 Uuq 690 542 Uub 693 |  | Period 229<br>543 Uuq 692 544 Uub 695 |  | Period 230<br>545 Uuq 694 546 Uub 697 |  | Period 231<br>547 Uuq 696 548 Uub 699 |  | Period 232<br>549 Uuq 698 550 Uub 701 |  | Period 233<br>551 Uuq 700 552 Uub 703 |  | Period 234<br>553 Uuq 702 554 Uub 705 |  | Period 235<br>555 Uuq 704 556 Uub 707 |  | Period 236<br>557 Uuq 706 558 Uub 709 |  | Period 237<br>559 Uuq 708 560 Uub 711 |  | Period 238<br>561 Uuq 710 562 Uub 713 |  | Period 239<br>563 Uuq 712 564 Uub 715 |  | Period 240<br>565 Uuq 714 566 Uub 717 |  | Period 241<br>567 Uuq 716 568 Uub 719 |  | Period 242<br>569 Uuq 718 570 Uub 721 |  | Period 243<br>571 Uuq 720 572 Uub 723 |  | Period 244<br>573 Uuq 722 574 Uub 725 |  | Period 245<br>575 Uuq 724 576 Uub 727 |  | Period 246<br>577 Uuq 726 578 Uub 729 |  | Period 247<br>579 Uuq 728 580 Uub 731 |  | Period 248<br>581 Uuq 730 582 Uub 733 |  | Period 249<br>583 Uuq 732 584 Uub 735 |  | Period 250<br>585 Uuq 734 586 Uub 737 |  | Period 251<br>587 Uuq 736 588 Uub 739 |  | Period 252<br>589 Uuq 738 590 Uub 741 |  | Period 253<br>591 Uuq 740 592 Uub 743 |  | Period 254<br>593 Uuq 742 594 Uub 745 |  | Period 255<br>595 Uuq 744 596 Uub 747 |  | Period 256<br>597 Uuq 746 598 Uub 749 |  | Period 257<br>599 Uuq 748 600 Uub 751 |  | Period 258<br>601 Uuq 750 602 Uub 753 |  | Period 259<br>603 Uuq 752 604 Uub 755 |  | Period 260<br>605 Uuq 754 606 Uub 757 |  | Period 261<br>607 Uuq 756 608 Uub 759 |  | Period 262<br>609 Uuq 758 610 Uub 761 |  | Period 263<br>611 Uuq 760 612 Uub 763 |  | Period 264<br>613 Uuq 762 614 Uub 765 |  | Period 265<br>615 Uuq 764 616 Uub 767 |  | Period 266<br>617 Uuq 766 618 Uub 769 |  | Period 267<br>619 Uuq 768 620 Uub 771 |  | Period 268<br>621 Uuq 770 622 Uub 773 |  | Period 269<br>623 Uuq 772 624 Uub 775 |  | Period 270<br>625 Uuq 774 626 Uub 777 |  | Period 271<br>627 Uuq 776 628 Uub 779 |  | Period 272<br>629 Uuq 778 630 Uub 781 |  | Period 273<br>631 Uuq 780 632 Uub 783 |  | Period 274<br>633 Uuq 782 634 Uub 785 |  | Period 275<br>635 Uuq 784 636 Uub 787 |  | Period 276<br>637 Uuq 786 638 Uub 789 |  | Period 277<br>639 Uuq 788 640 Uub 791 |  | Period 278<br>641 Uuq 790 642 Uub 793 |  | Period 279<br>643 Uuq 792 644 Uub 795 |  | Period 280<br>645 Uuq 794 646 Uub 797 |  | Period 281<br>647 Uuq 796 648 Uub 799 |  | Period 282<br>649 Uuq 798 650 Uub 801 |  | Period 283<br>651 Uuq 800 652 Uub 803 |  | Period 284<br>653 Uuq 802 654 Uub 805 |  | Period 285<br>655 Uuq 804 656 Uub 807 |  | Period 286<br>657 Uuq 806 658 Uub 809 |  | Period 287<br>659 Uuq 808 660 Uub 811 |  | Period 288<br>661 Uuq 810 662 Uub 813 |  | Period 289<br>663 Uuq 812 664 Uub 815 |  | Period 290<br>665 Uuq 814 666 Uub 817 |  | Period 291<br>667 Uuq 816 668 Uub 819 |  | Period 292<br>669 Uuq 818 670 Uub 821 |  | Period 293<br>671 Uuq 820 672 Uub 823 |  | Period 294<br>673 Uuq 822 674 Uub 825 |  | Period 295<br>675 Uuq 824 676 Uub 827 |  | Period 296<br>677 Uuq 826 678 Uub 829 |  | Period 297<br>679 Uuq 828 680 Uub 831 |  | Period 298<br>681 Uuq 830 682 Uub 833 |  | Period 299<br>683 Uuq 832 684 Uub 835 |  | Period 300<br>685 Uuq 834 686 Uub 837 |  | Period 301<br>687 Uuq 836 688 Uub 839 |  | Period 302<br>689 Uuq 838 690 Uub 841 |  | Period 303<br>691 Uuq 840 692 Uub 843 |  | Period 304<br>693 Uuq 842 694 Uub 845 |  | Period 305<br>695 Uuq 844 696 Uub 847 |  | Period 306<br>697 Uuq 846 698 Uub 849 |  | Period 307<br>699 Uuq 848 700 Uub 851 |  | Period 308<br>701 Uuq 850 702 Uub 853 |  | Period 309<br>703 Uuq 852 704 Uub 855 |  | Period 310<br>705 Uuq 854 706 Uub 857 |  | Period 311<br>707 Uuq 856 708 Uub 859 |  | Period 312<br>709 Uuq 858 710 Uub 861 |  | Period 313<br>711 Uuq 860 712 Uub 863 |  | Period 314<br>713 Uuq 862 714 Uub 865 |  | Period 315<br>715 Uuq 864 716 Uub 867 |  | Period 316<br>717 Uuq 866 718 Uub 869 |  | Period 317<br>719 Uuq 868 720 Uub 871 |  | Period 318<br>721 Uuq 870 722 Uub 873 |  | Period 319<br>723 Uuq 872 724 Uub 875 |  | Period 320<br>725 Uuq 874 726 Uub 877 |  | Period 321<br>727 Uuq 876 728 Uub 879 |  | Period 322<br>729 Uuq 878 730 Uub 881 |  | Period 323<br>731 Uuq 880 732 Uub 883 |  | Period 324<br>733 Uuq 882 734 Uub 885 |  | Period 325<br>735 Uuq 884 736 Uub 887 |  | Period 326<br>737 Uuq 886 738 Uub 889 |  | Period 327<br>739 Uuq 888 740 Uub 891 |  | Period 328<br>741 Uuq 890 742 Uub 893 |  | Period 329<br>743 Uuq 892 744 Uub 895 |  | Period 330<br>745 Uuq 894 746 Uub 897 |  | Period 331<br>747 Uuq 896 748 Uub 899 |  | Period 332<br>749 Uuq 898 750 Uub 901 |  | Period 333<br>751 Uuq 900 752 Uub 903 |  | Period 334<br>753 Uuq 902 754 Uub 905 |  | Period 335<br>755 Uuq 904 756 Uub 907 |  | Period 336<br>757 Uuq 906 758 Uub 909 |  | Period 337<br>759 Uuq 908 760 Uub 911 |  | Period 338<br>761 Uuq 910 762 Uub 913 |  | Period 339<br>763 Uuq 912 764 Uub 915 |  | Period 340<br>765 Uuq 914 766 Uub 917 |  | Period 341<br>767 Uuq 916 768 Uub 919 |  | Period 342<br>769 Uuq 918 770 Uub 921 |  | Period 343<br>771 Uuq 920 772 Uub 923 |  | Period 344<br>773 Uuq 922 774 Uub 925 |  | Period 345<br>775 Uuq 924 776 Uub 927 |  | Period 346<br>777 Uuq 926 778 Uub 929 |  | Period 347<br>779 Uuq 928 780 Uub 931 |  | Period 348<br>781 Uuq 930 782 Uub 933 |  | Period 349<br>783 Uuq 932 784 Uub 935 |  | Period 350<br>785 Uuq 934 786 Uub 937 |  | Period 351<br>787 Uuq 936 788 Uub 939 |  | Period 352<br>789 Uuq 936 |  |
|-----------------------|--|-----------------------------------|--|---------------------------------------|--|--------------------------------------|--|--------------------------------------|--|---------------------------------------|--|---------------------------------|--|--------------------------------------|--|----------------------------------------|--|------------------------------------------|--|---------------------------------------|--|------------------------------------------|--|-----------------------------------------|--|------------------------------------------|--|----------------------------------------|--|------------------------------------|--|---------------------------------------|--|--------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|------------------------------------|--|-------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|--------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|---------------------------------------|--|----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# Periodic Table Structure Info Sheet

The Periodic Table of the Elements

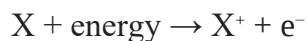
- ☐ Alkali metals
- ☐ Alkaline earth metals
- ☐ Transition metals
- ☐ Rare earth metals
- ☐ Metalloids (semi-metals)
- ☐ Other metals
- ☐ Non-metals
- ☐ Halogens
- ☐ Noble Gases

|                                                                                                                                                                                                                                                                                                 |  |                                |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  |                                                                                                                                                  |  |                                 |  |                                 |  |                                 |  |                               |  |                                   |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------|--|----|--|--|--|--|--|--|--|--|--|--|--|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------|--|---------------------------------|--|---------------------------------|--|-------------------------------|--|-----------------------------------|--|--|--|--|--|--|--|---------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <div>Transition metals</div> <div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div><div><div>Rare earth metals</div><div>Metalloids (semi-metals)</div><div>Other metals</div><div>Non-metals</div><div>Halogens</div><div>Noble Gases</div></div></div> |  |                                |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | <div>Element name → Mercury ← Atomic #</div> <div><div>80</div><div>←</div></div> <div><div>Symbol → Hg</div><div>200.59 ← Avg. Mass</div></div> |  |                                 |  |                                 |  |                                 |  |                               |  |                                   |  |  |  |  |  |  |  | <div>18</div> |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1                                                                                                                                                                                                                                                                                               |  | 2                              |  | 13 |  |  |  |  |  |  |  |  |  |  |  |  |  | 14                                                                                                                                               |  | 15                              |  | 16                              |  | 17                              |  | 18                            |  |                                   |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Hydrogen<br>1<br>H<br>1.01                                                                                                                                                                                                                                                                      |  | Helium<br>2<br>He<br>4.00      |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Boron<br>5<br>B<br>10.81                                                                                                                         |  | Carbon<br>6<br>C<br>12.01       |  | Nitrogen<br>7<br>N<br>14.01     |  | Oxygen<br>8<br>O<br>16.00       |  | Fluorine<br>9<br>F<br>19.00   |  | Neon<br>10<br>Ne<br>20.18         |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Lithium<br>3<br>Li<br>6.94                                                                                                                                                                                                                                                                      |  | Beryllium<br>4<br>Be<br>9.01   |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Aluminum<br>13<br>Al<br>26.98                                                                                                                    |  | Silicon<br>14<br>Si<br>28.09    |  | Phosphorus<br>15<br>P<br>30.97  |  | Sulfur<br>16<br>S<br>32.07      |  | Chlorine<br>17<br>Cl<br>35.45 |  | Argon<br>18<br>Ar<br>39.95        |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sodium<br>11<br>Na<br>22.99                                                                                                                                                                                                                                                                     |  | Magnesium<br>12<br>Mg<br>24.31 |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Gallium<br>31<br>Ga<br>69.72                                                                                                                     |  | Germanium<br>32<br>Ge<br>72.61  |  | Arsenic<br>33<br>As<br>74.92    |  | Selenium<br>34<br>Se<br>78.96   |  | Bromine<br>35<br>Br<br>79.90  |  | Krypton<br>36<br>Kr<br>83.80      |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Potassium<br>19<br>K<br>39.10                                                                                                                                                                                                                                                                   |  | Calcium<br>20<br>Ca<br>40.08   |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Indium<br>49<br>In<br>114.82                                                                                                                     |  | Tin<br>50<br>Sn<br>118.71       |  | Antimony<br>51<br>Sb<br>121.76  |  | Tellurium<br>52<br>Te<br>127.60 |  | Iodine<br>53<br>I<br>126.90   |  | Xenon<br>54<br>Xe<br>131.29       |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Rubidium<br>37<br>Rb<br>85.47                                                                                                                                                                                                                                                                   |  | Strontium<br>38<br>Sr<br>87.62 |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Cadmium<br>48<br>Cd<br>112.41                                                                                                                    |  | Silver<br>47<br>Ag<br>107.87    |  | Palladium<br>46<br>Pd<br>106.42 |  | Copper<br>29<br>Cu<br>63.55     |  | Zinc<br>30<br>Zn<br>65.39     |  |                                   |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Cesium<br>55<br>Cs<br>132.91                                                                                                                                                                                                                                                                    |  | Barium<br>56<br>Ba<br>137.33   |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Thallium<br>81<br>Tl<br>204.38                                                                                                                   |  | Lead<br>82<br>Pb<br>207.20      |  | Bismuth<br>83<br>Bi<br>208.98   |  | Polonium<br>84<br>Po<br>(209)   |  | Astatine<br>85<br>At<br>(210) |  | Radon<br>86<br>Rn<br>(222)        |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Francium<br>87<br>Fr<br>(223)                                                                                                                                                                                                                                                                   |  | Radium<br>88<br>Ra<br>(226)    |  |    |  |  |  |  |  |  |  |  |  |  |  |  |  | Uranium<br>92<br>U<br>238.03                                                                                                                     |  | Neptunium<br>93<br>Np<br>237.05 |  | Plutonium<br>94<br>Pu<br>244.06 |  | Americium<br>95<br>Am<br>243.06 |  | Curium<br>96<br>Cm<br>247.07  |  | Einsteinium<br>99<br>Es<br>287.10 |  |  |  |  |  |  |  |               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# Periodic Trends Info Sheet

## IONIZATION ENERGY

The minimum amount of energy required to remove the most loosely bound electron, the valence electron, of an isolated neutral gaseous atom to form a cation. It is quantitatively expressed in symbols as:

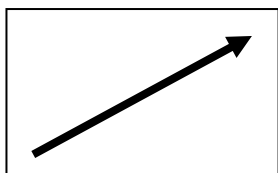


### In other words...

How much energy does it take to take away an electron from an atom?

### Trend

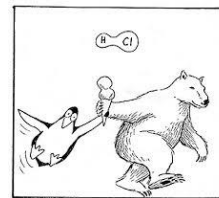
Increases →  
Increases ↑



Highest = Fluorine only higher are Noble Gases (Rn)  
Lowest = Francium

## ELECTRONEGATIVITY

The tendency of an atom to attract a shared pair of electrons (or electron density) towards itself.

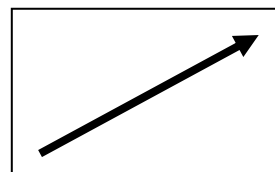


### In other words...

How strong is the atom? How hard can it pull on electrons when sharing them with another atom?

### Trend

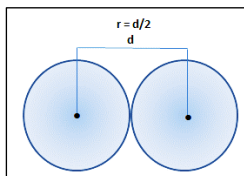
Increases →  
Increases ↑



Highest = Fluorine  
Lowest = Francium only lower are Noble Gases (He)

## ATOMIC RADIUS

Usually the mean or typical distance from the center of the nucleus to the boundary of the surrounding cloud of electrons. Since the boundary is not a well-defined physical entity, there are various non-equivalent definitions of atomic radius.

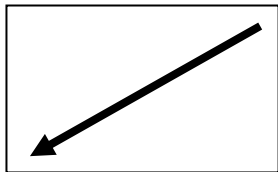


### In other words...

Half the diameter of an atom. Hard to measure because atoms do not have actual tangible edges. Lots of ways to measure it.

### Trend

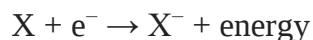
Increases ←  
Increases ↓



Highest = Francium  
Lowest = Helium

## ELECTRON AFFINITY

The amount of energy released\* when an electron is added to one mole of a neutral atom, or molecule, in the gaseous state to form a negative ion. Usually written as a  $\Delta E$  value.

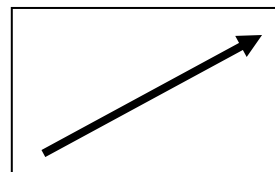


### In other words...

How happy is the atom to gain that new electron?  
Really happy – much more stable, releases lots of energy. Not happy – not as much stability, doesn't release lots of energy.

### Trend

Increases →  
Increases ↑



Highest = Fluorine  
Lowest = Francium only lower are Noble Gases (zero)

\*Some electron affinities are actually positive  $\Delta E$  – meaning energy is absorbed. They are not commonly talked about or used though.

# Periodic Trends Info Sheet

## REACTIVITY

The impetus for which a chemical substance undergoes a chemical reaction, either by itself or with other materials, with an overall release of energy.

### In other words...

How quickly, violently, readily, does an element undergo certain reactions. More reactivity means faster, more violent, easier reaction with lots of energy released.

### Trend

Metals

Increase  $\downarrow \leftarrow$

Non-metals

Increases  $\uparrow \rightarrow$



Highest metal = Francium

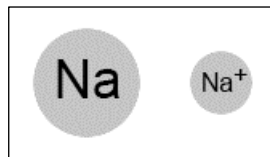
Highest non-metal = Fluorine

Lowest non-metal = Noble gases (He)

## IONIC RADIUS

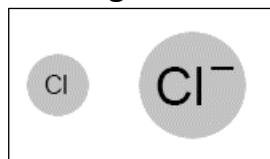
### Cations:

Get smaller when they lose electrons



### Anions:

Get larger when they gain electrons



## EFFECTIVE NUCLEAR CHARGE - $Z_{eff}$

The pull that the nucleus has on electrons

$$Z_{eff} = Z - S$$

$Z$  = # of protons

$S$  = Core/Inner electrons (# of electrons in previous noble gas + any d or f electrons)

## SUBSEQUENT IONIZATIONS

1st ionization energy



2nd ionization energy



3rd ionization energy



Ionization energy increases with each subsequent ionization because there is more attraction between the nucleus and the valence electrons each time you lower the number of valence electrons.

There is a huge leap in ionization energy once an atom loses all its valence electrons because it now looks like a noble gas and really doesn't want to let go of any more electrons!

## SHIELDING

When the inner/core electrons repel the valence electrons and prevents them from seeing the nucleus. Decreases how strongly the electrons are held onto by the nucleus.

## BREAKS IN PATTERNS

There are *many* examples of elements that do not appear to follow the general trends typically described. This can be due to a variety of reasons. Here are two of many reasons why this can happen.

- Half-filled orbitals have slightly more stability than expected

Example: p orbital set:  $\uparrow$   $\uparrow$   $\uparrow$

- Unpairing an electron takes slightly less energy than expected b/c extra electron repulsions

Example: p orbital set:  $\uparrow\downarrow$   $\uparrow$   $\uparrow$

# Warning...

- Don't over think this stuff.
- You can talk yourself into backwards answers.
- Focus on the fact that there are only a set number of trends to learn.
- Practice explaining each trend until you can do it in your sleep!
- There will ALWAYS be exceptions. Don't worry about that — focus on the pattern and answer questions based on the patterns.

# Warning...

- There is about to be a lot of notes because it takes a lot of words to explain
- You don't need EVERY word written down to understand it.
- Focus on listening and understanding.
- You can add to your notes at home.
- Capture enough to pay attention, leave space to come back and add/annotate.

# Warning...

Make sure you capture:

What  
How  
Why

Make sure you can tell me:

What  
How  
Why

## Periodic Trends

## Atomic Radius

### ATOMIC RADIUS

| What                                                                                                                                                                                   | How |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <ul style="list-style-type: none"> <li>• <math>\frac{1}{2}</math> the distance between two bonded nuclei</li> <li>• Can't measure to the edge b/c orbitals aren't tangible!</li> </ul> |     |

### ATOMIC RADIUS

#### Why

##### INCREASES DOWN

- Adding energy levels  
Smaller "effective nuclear charge"
- Inner e- keep valence e- from "feeling" the nucleus
- Outer e- are not as pulled in by the protons in the nucleus — there is more "shielding" by the inner electrons

##### DECREASES TO RIGHT

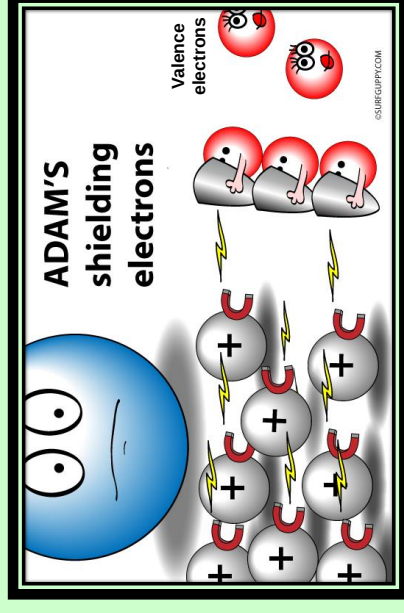
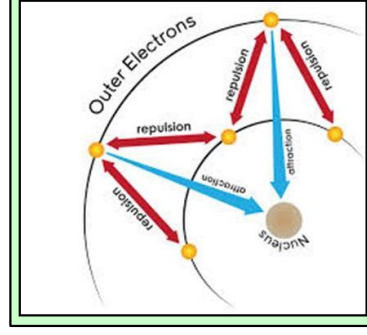
- Adding a proton = bigger change than adding an e-
- More protons pull the valence electrons in closer - "Greater Effective Nuclear Charge"
- No increase in shielding b/c no new energy levels

#### Effective Nuclear Charge ( $Z_{eff}$ )

The relative attraction the valence electrons have for the protons in the nucleus

#### Shielding Effect

The inner shell electrons repel the outer valence electrons — keeps the valence e- from "feeling" the nucleus. More energy levels - lowers the effective nuclear charge



## Calculating Effective Nuclear Charge

The relative attraction the valence electrons have for the protons in the nucleus

$$Z_{\text{eff}} = Z - S$$

**Z** = nuclear attraction = # protons

**S** = the core/inner e<sup>-</sup> shielding the valence e<sup>-</sup>'s  
= the total number of e<sup>-</sup> minus the e<sup>-</sup> in the highest occupied s and p energy levels  
= (# of e<sup>-</sup> in previous noble gas + any d or f e<sup>-</sup>'s past the noble gas in the element)

## Calculating Effective Nuclear Charge

$$Z_{\text{eff}} = Z - S$$

### Magnesium

Z = 12 protons  
S = Previous noble gas  
= Neon = 10 electrons  
Z<sub>eff</sub> = 12 - 10 = 2

### Aluminum

Z = 13 protons  
S = Previous noble gas  
= Neon = 10 electrons  
Z<sub>eff</sub> = 13 - 10 = 3

Aluminum is smaller  
– valence electrons  
are pulled in harder  
by the nucleus

## IONIC RADIUS

### Why

#### CATION SMALLER

- Reduced repulsion between electrons
- If you lose enough electrons you even drop down an energy level! Much smaller!

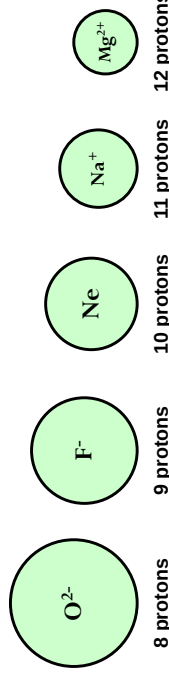
#### ANION LARGER

- Extra valence electrons repel each other a bit more so it gets larger.

## Isoelectric Species

Atoms/Ions that have the same number of e<sup>-</sup>

All these examples are  $1s^2 2s^2 2p^6$



Increased protons can pull harder on the valence electrons – greater effective nuclear charge – so the radius is smaller even though they have the same number of electrons and energy levels

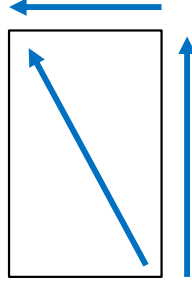
# Ionization Energy

## IONIZATION ENERGY

### What

The energy required to remove an electron from a neutral atom of an element

### How



Noble Gases are HIGHEST!  
They REALLY don't want to let go of an e<sup>-</sup>

## IONIZATION ENERGY

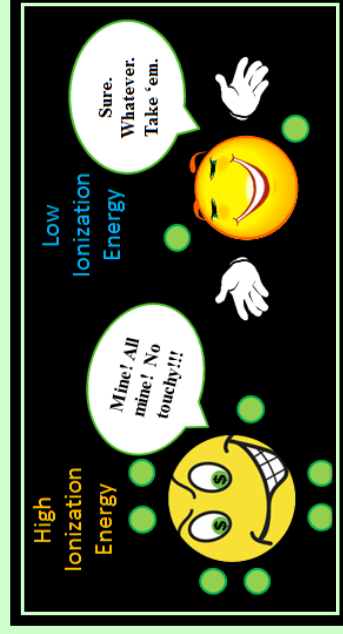
### Why

#### DECREASES DOWN

- Electrons are further from nucleus in higher energy levels
- Increased shielding from core e<sup>-</sup> causes nucleus to not pull as hard on valence e<sup>-</sup>
- Lower effective nuclear charge – so they are more easily removed

#### INCREASES TO RIGHT

- Closer to having a full stable valence shell
- Increased effective nuclear charge means nucleus is pulling harder on the valence e<sup>-</sup> so they are harder to remove

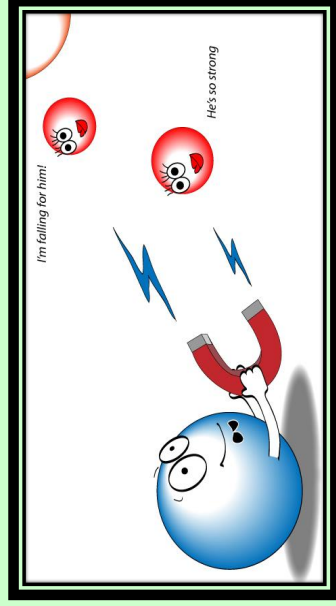


## Subsequent Ionizations

Every time you take an e- away it gets harder to take the next one. Radius is getting smaller, so nucleus can pull harder on the valence - harder to remove the next one. HUGE LEAP in I.E. once it's achieved noble gas configuration - why would it want to lose another one?!

| Element | IE <sub>1</sub> | IE <sub>2</sub> | IE <sub>3</sub> | IE <sub>4</sub> |
|---------|-----------------|-----------------|-----------------|-----------------|
| Na      | 496             | 4560            |                 |                 |
| Mg      | 738             | 1450            | 7730            |                 |
| Al      | 578             | 1820            | 2750            | 11,600          |

## Electronegativity



## ELECTRONEGATIVITY

### Why

#### DECREASES DOWN

- e- are further from nucleus in higher energy levels
- Increased shielding from core e- causes nucleus to not pull as hard on valence e-
- So nucleus doesn't pull as hard on the bonding e-'s from another atom

#### INCREASES TO RIGHT

- Smaller radius, increased effective nuclear charge
- Nucleus is pulling harder on the valence electrons - which is where the bonding is occurring.

## Electron Affinity

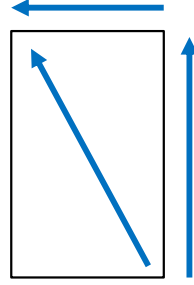
## ELECTRON AFFINITY

### What

How much energy is released when the atom gains an electron to make a negative ion.

How much stability does it gain once it is an anion. More energy released - more stable.

### How



Noble Gases are LOWEST! They DON'T CARE about attracting electrons!

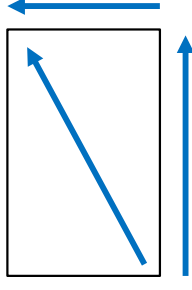
## ELECTRONEGATIVITY

### What

A measure of the ability of an atom in a chemical compound to attract electrons from another atom in the compound

How strongly can one atom pull on the electrons being shared in a bond.

### How



Noble Gases are LOWEST! They DON'T CARE about attracting electrons!

## ELECTRON AFFINITY

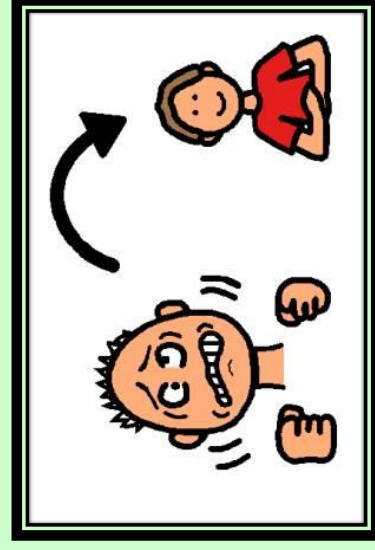
### Why

#### DECREASES DOWN

- Electrons are further from nucleus in higher energy levels
- Increased shielding from core e-'s causes the nucleus to not pull as hard on valence e-'s
- So atom doesn't notice as much if it gains an electron - doesn't gain much stability

#### INCREASES TO RIGHT

- Closer to filling valence shell - noble gas configuration is most stable



# Reactivity

# Summary

## REACTIVITY

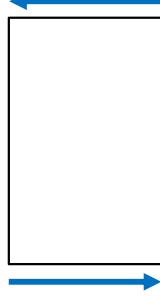
What

Elements in the same group have similar types of behaviors because they have the same number of valence e-

BUT

The MAGNITUDE of their reactions changes!

How



## REACTIVITY

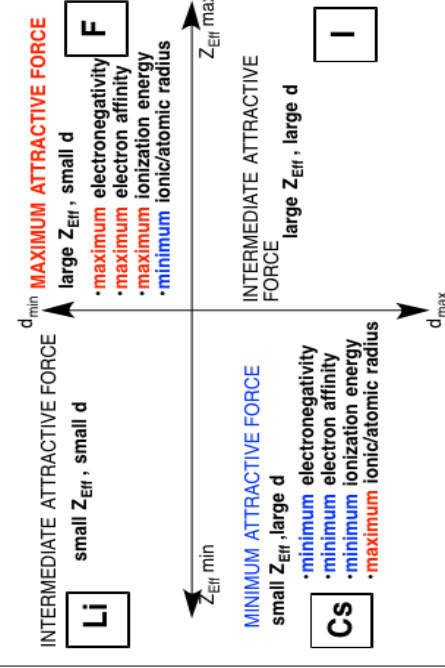
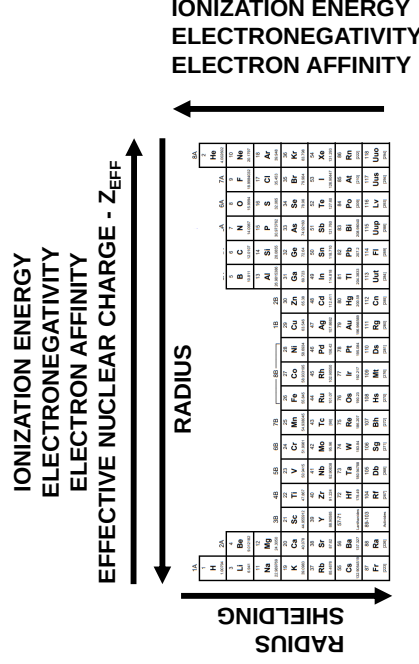
Why

METALS INCREASE DOWN

- Larger radius and increased shielding means lower ionization energy so it is easier to remove electrons

NON-METALS INCREASE UP

- Smaller radius and greater effective nuclear charge means higher electronegativity and electron affinity so it can attract an electron easier



Brainiac Video — note: they augmented the reactions, but it is such a fun, silly, memorable video I think it is still worth watching 😊

Disposal of Sodium — old footage from WWII. Neat to see such old footage and how they actually disposed of the sodium after the war!

*Quick summary. Also has a quick but good explanation of some exceptions to the trends*

<https://www.youtube.com/watch?v=hePb00CqvPQ>