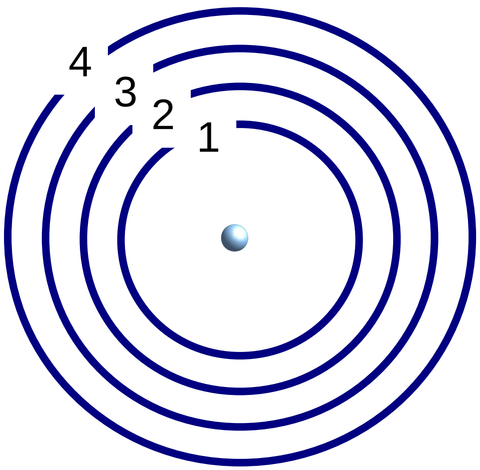
PHY100 — Recitation #5

1) In the Bohr model of the atom, what happens to the electron when the atom absorbs a photon?

What happens to the electron when the atom emits a photon?



Imagine the atom in the scheme on the left has four different states (orbits) in which the electron can exist. Below you can see a graphical representation of the electron energy in each possible state ($E_1<E_2<E_3<E_4$)

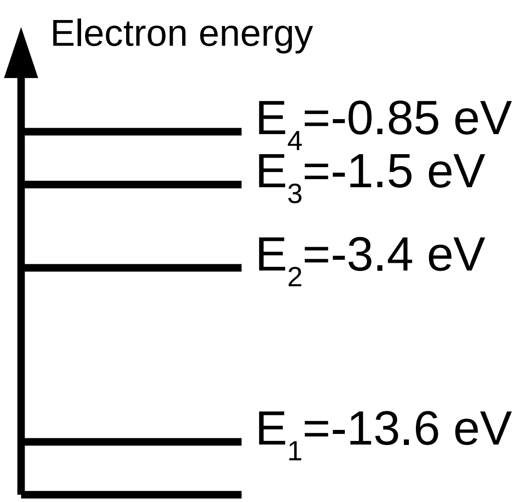
a) In terms of E_1, E_2, E_3 and E_4, what is the energy of the most energetic photon emitted by this atom?

b) In terms of E_1, E_2, E_3 and E_4, what is the energy of the least energetic photon emitted by this atom?

Now use the values of the energies given and the fact that $h=6.6\times10^{-34}$ Js (or 4.1×10^{-21} MeVs):

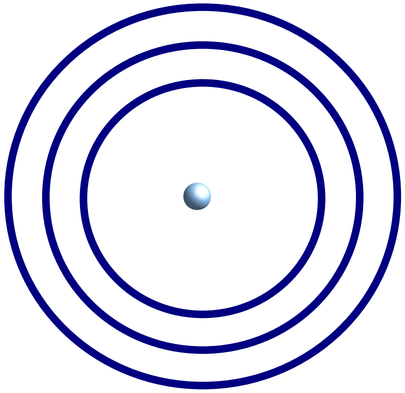
c) What is the highest frequency light emitted by this atom?

d) What is the lowest frequency light emitted by this atom?



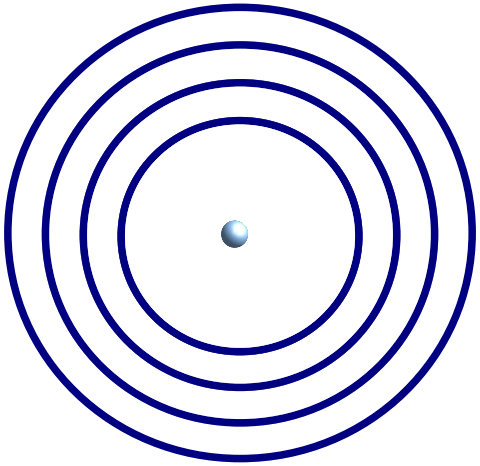
Look on p196 of Hobson to determine the region of the electromagnetic spectrum where light of this frequency would be found.

I know the – sign in the energies on the left is weird! It means the electron is bound by the atom: think of scale as offset from zero



2) Imagine an atom has 3 possible energy states in which the electron could exist.

How many spectral lines could be emitted by this atom?

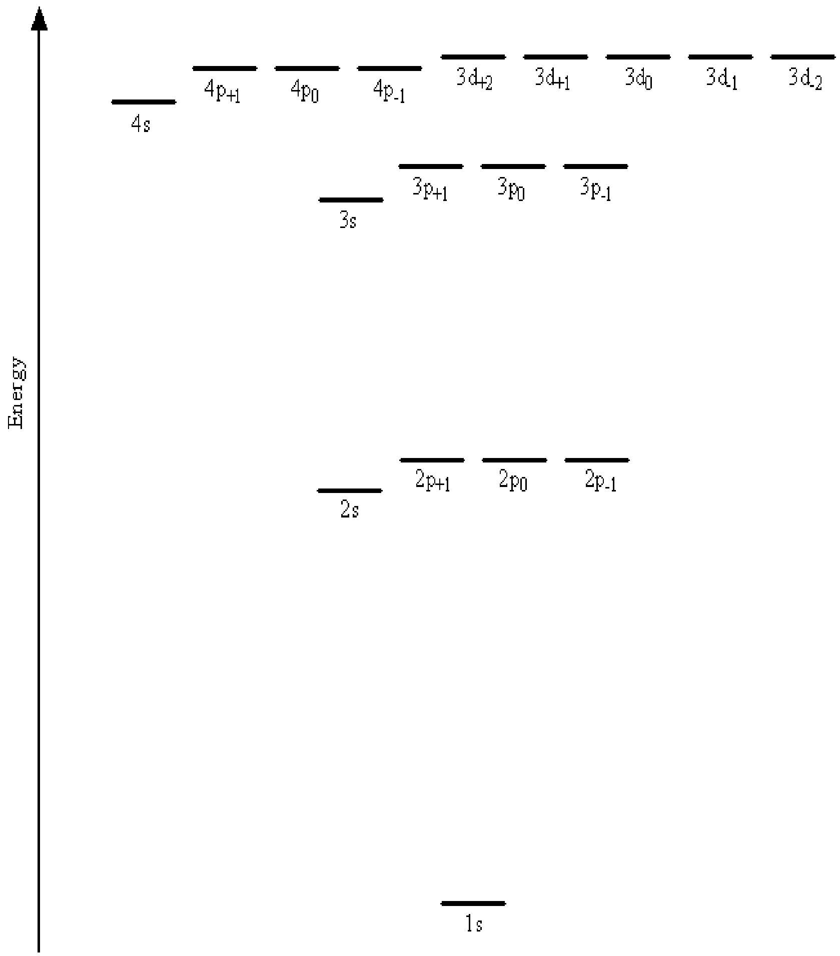


3) Imagine an atom has 4 possible energy states in which the electron could exist.

How many spectral lines could be emitted by this atom?

4) When you calculate the energy of a multi-electron atom using a full-blown quantum mechanical treatment, the atom is most stable if it has all the possible quantum states in its outermost energy level filled.

We saw in class the allowed energy levels of the electrons in the atom were a solution of the Schrodinger equation. And that these are the first few, called: 1s, 2s, 2p, 3s, 3p, etc... in order of ascending energy:

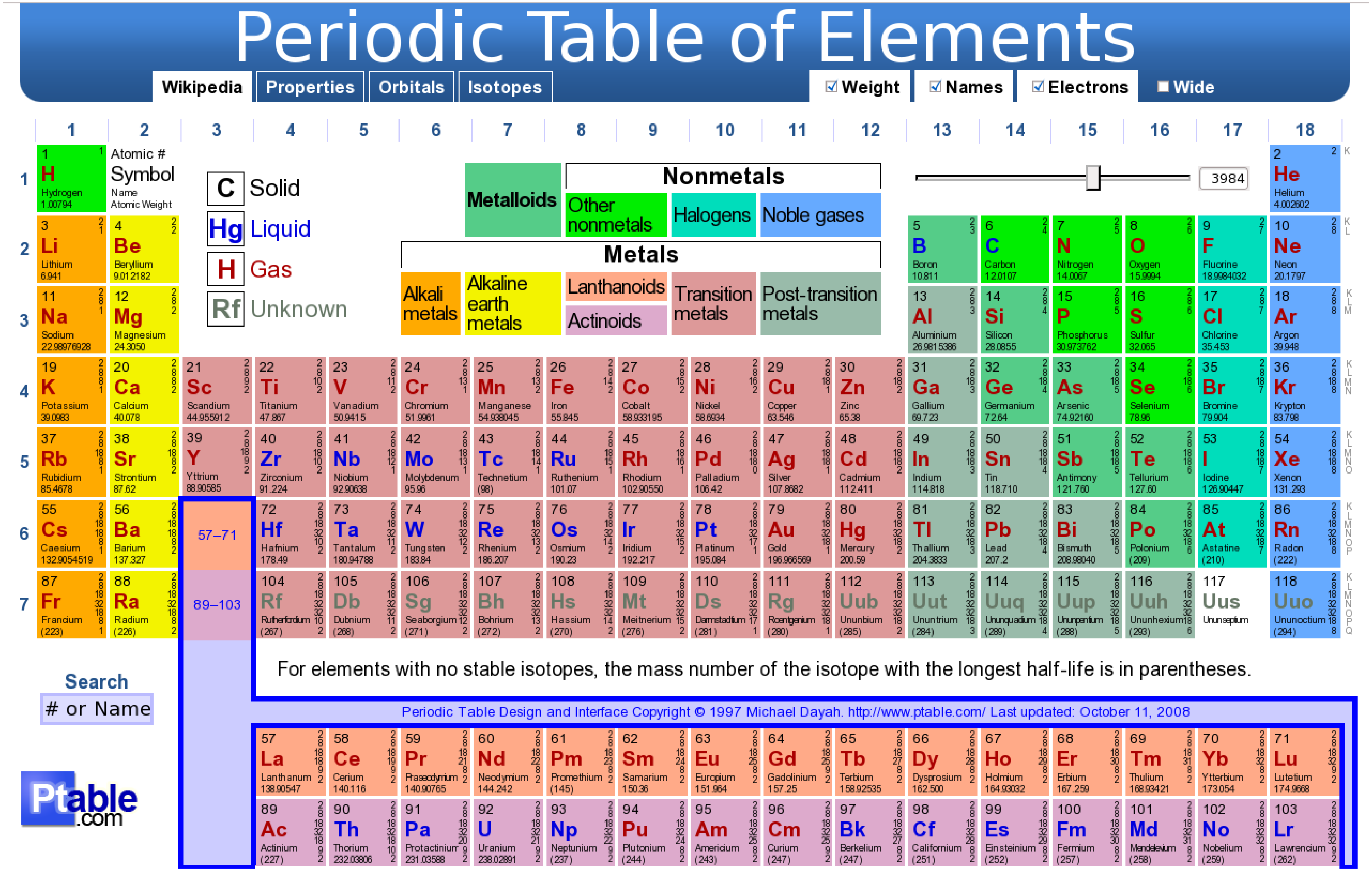


Energy level	# of e allowed
1s	2
2s	2
2p	6
3s	2
3p	6

Remember: Only **two** electrons (fermions) can occupy one given quantum state.

One e with spin +1/2 and the other with -1/2

Now look at the periodic table in the next page:



Periodic Table of Elements
Wikipedia
Properties
Orbitals
Isotopes
Weight
Names
Electrons
Wide
Atomic #
Symbol
Name
Atomic Weight
C Solid
Hg Liquid
H Gas
Rf Unknown
Metalloids
Nonmetals
Other nonmetals
Halogens
Noble gases
Metals
Alkali metals
Alkaline earth metals
Lanthanoids
Actinoids
Transition metals
Post-transition metals
3984
1 H Hydrogen 1.00794
2 He Helium 4.002602
3 Li Lithium 6.941
4 Be Beryllium 9.012182
5 B Boron 10.811
6 C Carbon 12.0107
7 N Nitrogen 14.0067
8 O Oxygen 15.9994
9 F Fluorine 18.9984032
10 Ne Neon 20.1797
11 Na Sodium 22.98976928
12 Mg Magnesium 24.3050
13 Al Aluminium 26.9815386
14 Si Silicon 28.0855
15 P Phosphorus 30.973762
16 S Sulfur 32.065
17 Cl Chlorine 35.453
18 Ar Argon 39.948
19 K Potassium 39.0983
20 Ca Calcium 40.078
21 Sc Scandium 44.955912
22 Ti Titanium 47.867
23 V Vanadium 50.9415
24 Cr Chromium 51.9961
25 Mn Manganese 54.938045
26 Fe Iron 55.845
27 Co Cobalt 58.933195
28 Ni Nickel 58.6934
29 Cu Copper 63.546
30 Zn Zinc 65.38
31 Ga Gallium 69.723
32 Ge Germanium 72.64
33 As Arsenic 74.92160
34 Se Selenium 78.96
35 Br Bromine 79.904
36 Kr Krypton 83.798
37 Rb Rubidium 85.4678
38 Sr Strontium 87.62
39 Y Yttrium 88.90585
40 Zr Zirconium 91.224
41 Nb Niobium 92.90638
42 Mo Molybdenum 95.96
43 Tc Technetium (98)
44 Ru Ruthenium 101.07
45 Rh Rhodium 102.90550
46 Pd Palladium 106.42
47 Ag Silver 107.8682
48 Cd Cadmium 112.411
49 In Indium 114.818
50 Sn Tin 118.710
51 Sb Antimony 121.760
52 Te Tellurium 127.60
53 I Iodine 126.90447
54 Xe Xenon 131.293
55 Cs Caesium 132.9054519
56 Ba Barium 137.327
57–71
72 Hf Hafnium 178.49
73 Ta Tantalum 180.94788
74 W Tungsten 183.84
75 Re Rhenium 186.207
76 Os Osmium 190.23
77 Ir Iridium 192.217
78 Pt Platinum 195.084
79 Au Gold 196.966569
80 Hg Mercury 200.59
81 Tl Thallium 204.3833
82 Pb Lead 207.2
83 Bi Bismuth 208.98040
84 Po Polonium (209)
85 At Astatine (210)
86 Rn Radon (222)
87 Fr Francium (223)
88 Ra Radium (226)
89–103
104 Rf Rutherfordium (267)
105 Db Dubnium (268)
106 Sg Seaborgium (271)
107 Bh Bohrium (272)
108 Hs Hassium (270)
109 Mt Meitnerium (276)
110 Ds Darmstadtium (281)
111 Rg Roentgenium (280)
112 Uub Ununbium (285)
113 Uut Ununtrium (284)
114 Uuq Ununquadium (289)
115 Uup Ununpentium (288)
116 Uuh Ununhexium (293)
117 Uus Ununseptium
118 Uuo Ununoctium (294)
For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.
Search
or Name
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57 La Lanthanum 138.90547
58 Ce Cerium 140.116
59 Pr Praseodymium 140.90765
60 Nd Neodymium 144.242
61 Pm Promethium (145)
62 Sm Samarium 150.36
63 Eu Europium 151.964
64 Gd Gadolinium 157.25
65 Tb Terbium 158.92535
66 Dy Dysprosium 162.500
67 Ho Holmium 164.93032
68 Er Erbium 167.259
69 Tm Thulium 168.93421
70 Yb Ytterbium 173.054
71 Lu Lutetium 174.9668
89 Ac Actinium (227)
90 Th Thorium 232.03806
91 Pa Protactinium 231.03588
92 U Uranium 238.02891
93 Np Neptunium (237)
94 Pu Plutonium (244)
95 Am Americium (243)
96 Cm Curium (247)
97 Bk Berkelium (247)
98 Cf Californium (251)
99 Es Einsteinium (252)
100 Fm Fermium (257)
101 Md Mendelevium (258)
102 No Nobelium (259)
103 Lr Lawrencium (262)
Ptable.com

a) How can you tell the number of protons in each element listed?

b) Elements are defined primarily by their chemical characteristics. What do I mean by this?

c) Considering atoms with Z=1 (Hydrogen = H) through Z=18 (Argon=Ar), which elements would you expect to be most stable (least chemically reactive)?

d) Can you determine the number of neutrons for each element listed in the periodic table?

e) Do you think the number of neutrons in an atom's nucleus has an effect on its chemical characteristics? Why?

f) Which atom would you expect to be larger... Z=10 (Neon=Ne) or Z=18 (Argon=Ar)?

5) Hydrogen (Z=1, H) reacts with chlorine (Z=17, Cl) to form Hydrogen chloride molecules which consist of 1 H and 1 Cl atom, written as HCl.

a) From what you know about quantum stability and its dependence on the electron configuration (how the electrons fill the available orbitals), can you motivate why H and Cl join in a 1-to-1 ratio?

b) What other atoms would you expect to join with chlorine in a 1-to-1 ratio in a chemical reaction?

c) What do you suppose might be the ratio of Magnesium (Mg) to Chlorine (Cl) after a chemical reaction?