

Physics 100 - Spring 2009 - Recitation 6

- ① Two jugglers toss batons back and forth.
How are they like a chemical bond?
Are they more like an ionic bond
or a covalent bond?
- ② A 142 gram baseball is thrown at 92 mph (41 m/s).
Suppose you measure the velocity of the baseball to
a precision of $.000000001 \text{ m/s} = 10^{-9} \text{ m/s}$, how
well could you measure the instantaneous position
of the baseball if you had an instrument able
to measure positions perfectly? (Assume the mass
of the baseball is exactly 142 grams.)

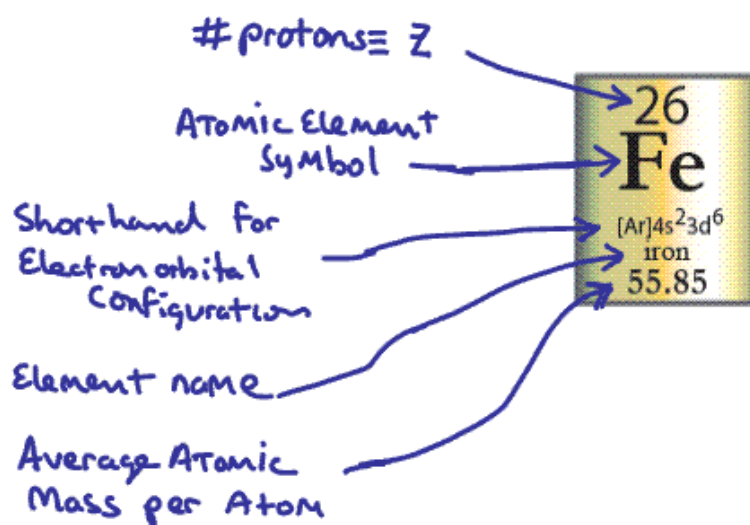
③ IT happens that when you calculate the energy of a multi-electron atom using a full-blown quantum mechanical treatment, the atom is most stable if it has all the possible quantum states in its outermost energy level filled.

(a) What do I mean by the words "most stable"?

According to quantum mechanics:

	Energy level	Number of electrons Allowed
Increasing energy ↓	1S	2
	2S	2
	2P	6
	3S	2
	3P	6

names of available quantum states (distribute these in lecture)



In a typical entry for each element of a periodic chart, you will see the various components above. Make sure you understand each of these things ... except for the electron configuration shorthand.

(b) Look on the Periodic Chart. How can you tell the Number of protons in each element?

(c) ^{56}Fe has how many protons and how many neutrons?

How about ^{57}Fe ?

- (d) Elements are defined primarily by their chemical characteristics.

What do I mean by this?

- (e) Considering atoms with $Z=1$ (hydrogen ${}^1\text{H}$) through $Z=18$ (Argon $\equiv \text{Ar}$), which elements would you expect to be most stable (least chemically reactive)?

- (f) Can you determine the number of neutrons for each element listed in the Periodic chart?

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

- (h) Which atom would you expect to be larger ... ?
 $\text{Ne} \equiv \text{Neon}$ or $\text{Ar} \equiv \text{Argon}$
 $Z=10$ $Z=18$

[illegible]

1A	1 H hydrogen 1.008	2A	3 Li lithium 6.941	4 Be beryllium 9.012	5B	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.69	29 Cu copper 63.55	30 Zn zinc 65.39	31 Ga gallium 69.72	32 Ge germanium 72.64	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80	37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium (98)	44 Ru ruthenium 98.91	45 Rh rhodium 101.07	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.29	55 Cs cesium 132.91	56 Ba barium 137.33	57 La* lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (145)	62 Sm samarium 150.36	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium (209)	85 At astatine (210)	86 Rn radon 222	87 Fr francium 223	88 Ra radium 226	89 Ac~ actinium without electron (227)	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium 237.05	94 Pu plutonium 244.06	95 Am americium 243.06	96 Cm curium 247.07	97 Bk berkelium 247.07	98 Cf californium 251.08	99 Es einsteinium 252.08	100 Fm fermium 257.10	101 Md mendelevium 258.10	102 No nobelium 259.10	103 Lr lawrencium 262.10	104 Rf rutherfordium 261.10	105 Db dubnium 262.10	106 Sg seaborgium 266.10	107 Bh bohrium 264.10	108 Hs hassium 277.10	109 Mt meitnerium (268)	110 Ds darmstadtium (271)	111 Uuh unnilium (272)	112 Uub ununium (273)	113 Uut ununium (274)	114 Uuq unquadium (275)	115 Uup unpentium (276)	116 Uuh unhexium (277)	117 Uus unseptium (278)	118 Uuo unoctium (279)	119 Uue unenneium (280)	120 Uuh unbinilium (281)	121 Ubu unbinilium (282)	122 Ubs unbinilium (283)	123 Ubt unbinilium (284)	124 Ubu unbinilium (285)	125 Ubs unbinilium (286)	126 Ubt unbinilium (287)	127 Ubu unbinilium (288)	128 Ubs unbinilium (289)	129 Ubt unbinilium (290)	130 Ubu unbinilium (291)	131 Ubs unbinilium (292)	132 Ubt unbinilium (293)	133 Ubu unbinilium (294)	134 Ubs unbinilium (295)	135 Ubt unbinilium (296)	136 Ubu unbinilium (297)	137 Ubs unbinilium (298)	138 Ubt unbinilium (299)	139 Ubu unbinilium (300)	140 Ubs unbinilium (301)	141 Ubt unbinilium (302)	142 Ubu unbinilium (303)	143 Ubs unbinilium (304)	144 Ubt unbinilium (305)	145 Ubu unbinilium (306)	146 Ubs unbinilium (307)	147 Ubt unbinilium (308)	148 Ubu unbinilium (309)	149 Ubs unbinilium (310)	150 Ubt unbinilium (311)	151 Ubu unbinilium (312)	152 Ubs unbinilium (313)	153 Ubt unbinilium (314)	154 Ubu unbinilium (315)	155 Ubs unbinilium (316)	156 Ubt unbinilium (317)	157 Ubu unbinilium (318)	158 Ubs unbinilium (319)	159 Ubt unbinilium (320)	160 Ubu unbinilium (321)	161 Ubs unbinilium (322)	162 Ubt unbinilium (323)	163 Ubu unbinilium (324)	164 Ubs unbinilium (325)	165 Ubt unbinilium (326)	166 Ubu unbinilium (327)	167 Ubs unbinilium (328)	168 Ubt unbinilium (329)	169 Ubu unbinilium (330)	170 Ubs unbinilium (331)	171 Ubt unbinilium (332)	172 Ubu unbinilium (333)	173 Ubs unbinilium (334)	174 Ubt unbinilium (335)	175 Ubu unbinilium (336)	176 Ubs unbinilium (337)	177 Ubt unbinilium (338)	178 Ubu unbinilium (339)	179 Ubs unbinilium (340)	180 Ubt unbinilium (341)	181 Ubu unbinilium (342)	182 Ubs unbinilium (343)	183 Ubt unbinilium (344)	184 Ubu unbinilium (345)	185 Ubs unbinilium (346)	186 Ubt unbinilium (347)	187 Ubu unbinilium (348)	188 Ubs unbinilium (349)	189 Ubt unbinilium (350)	190 Ubu unbinilium (351)	191 Ubs unbinilium (352)	192 Ubt unbinilium (353)	193 Ubu unbinilium (354)	194 Ubs un
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element names in **blue** are liquids at room temperature
 element names in **red** are gases at room temperature
 element names in **black** are solids at room temperature

④ 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

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?

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

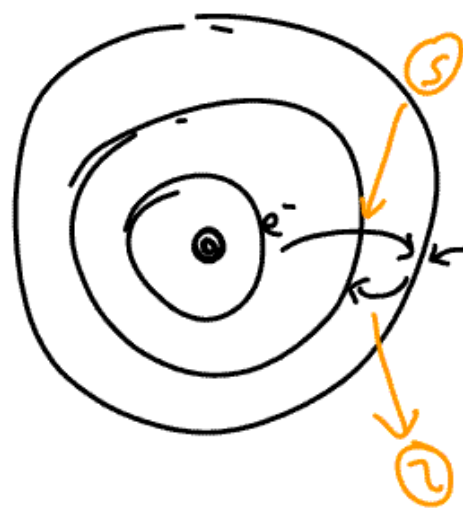
What do you suppose might be the ratio of Magnesium (Mg) to chlorine (Cl) after a chemical reaction?

5

How well can you measure the speed of an electron in a hydrogen atom (in principle)?

Most excited STATE orbitals in an atom only exist

for a very short time (known as the lifetime) before the STATE decays emitting a photon while the e^- jumps to a lower energy orbital.



only here
for a
short time

What does

Heisenberg's uncertainty

Principle tell you this will do to the color of the emitted photon?