

Physics 100 - Spring 2007 - 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

Look on the periodic chart.

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

(c) Elements are defined primarily by their chemical characteristics.

What do I mean by this?

(d) Considering atoms with $Z=1$ (hydrogen) through $Z=18$ (Argon \equiv Ar), which elements would you expect to be most stable (least chemically reactive)?

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

(f) Do you think the number of neutrons in an atom's nucleus has an affect on it's chemical characteristics?

(g) Which ATOM would you expect to be larger ... ?

Ne \equiv Neon or Ar \equiv Argon
 $Z=10$ $Z=18$

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Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B	11B	12B	3A	4A	5A	6A	7A	8A																																																																																																				
1 H hydrogen 1.008	2 He helium 4.003	3 Li lithium 6.941	4 Be beryllium 9.012	5 B boron 10.81	6 C carbon 12.01	7 N nitrogen 14.01	8 O oxygen 16.00	9 F fluorine 18.998	10 Ne neon 20.18	11 Na sodium 22.99	12 Mg magnesium 24.31	13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulfur 32.07	17 Cl chlorine 35.45	18 Ar argon 39.95	19 K potassium 39.10	20 Ca calcium 40.08	21 Sc scandium 44.96	22 Ti titanium 47.88	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 65.38	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 (99)	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3	55 Cs cesium 132.9	56 Ba barium 137.3	57 La* lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium (145)	62 Sm samarium 150.4	63 Eu europium 151.9	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 174.9	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 208.9	84 Po polonium (209)	85 At astatine (210)	86 Rn radon (222)	87 Fr francium (223)	88 Ra radium (226)	89 Ac~ actinium (227)	90 Th thorium 232.0	91 Pa protactinium (231)	92 U uranium (238)	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 (260)	104 Rf rutherfordium (261)	105 Db dubnium (262)	106 Sg seaborgium (263)	107 Bh bohrium (264)	108 Hs hassium (265)	109 Mt meitnerium (266)	110 Ds darmstadtium (271)	111 Uuu ununoctium (272)	112 Uub ununbium (277)	113 Uuq ununquadium (284)	114 Uuq ununquadium (284)	115 Uuh ununhexium (285)	116 Uuo ununhexium (286)

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

Lanthanide Series*

Actinide Series~



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?

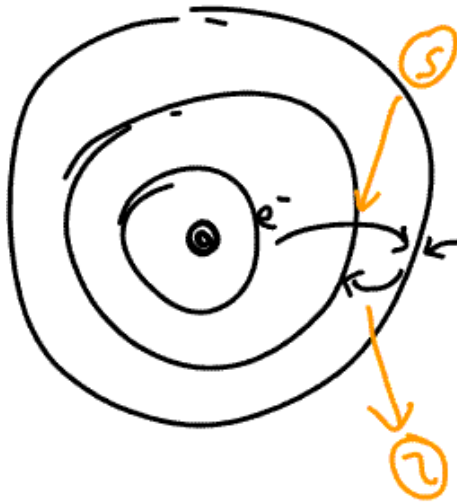
5

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

6

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?