

Physics 102 - Fall 2009 - 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?

Below is a schematic diagram of an atom with four different states (or orbits) in which the electron could exist. Next to it is a graphical representation of the electron energy in each possible STATE ... $E_1 < E_2 < E_3 < E_4$.

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

In terms of E_1, E_2, E_3, E_4 , what is the energy of the least energetic photon?

Suppose for a moment that

$$E_1 = -13.6 \text{ eV}$$

$$E_2 = -3.4 \text{ eV}$$

$$E_3 = -1.5 \text{ eV}$$

$$E_4 = -0.85 \text{ eV}$$

$$h = 6.6 \times 10^{-34} \text{ J}\cdot\text{s}$$

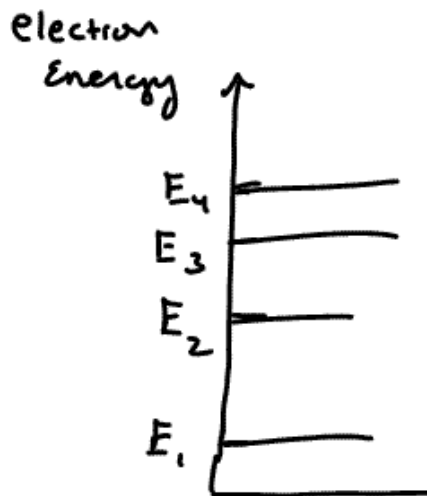
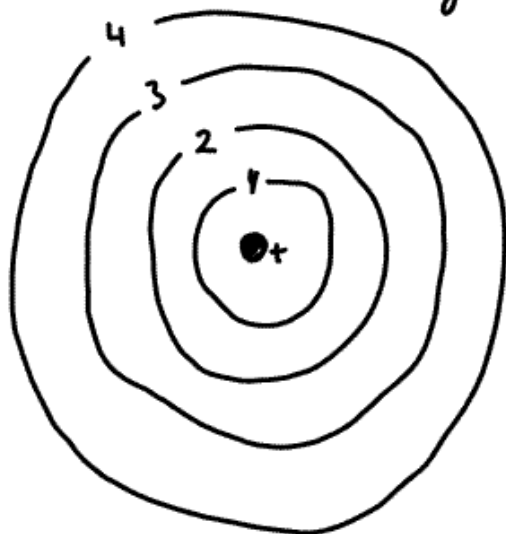
or

$$4.1 \times 10^{-21} \text{ MeV}\cdot\text{s}$$

I know the "-" sign seems strange ... it means the electron is bound in the atom. Just think of scale as offset from zero.

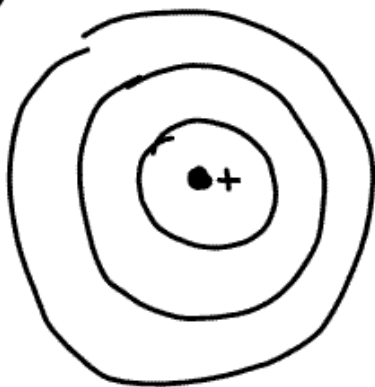
What is the highest frequency light emitted by this atom?

What is the lowest frequency light emitted by this atom?



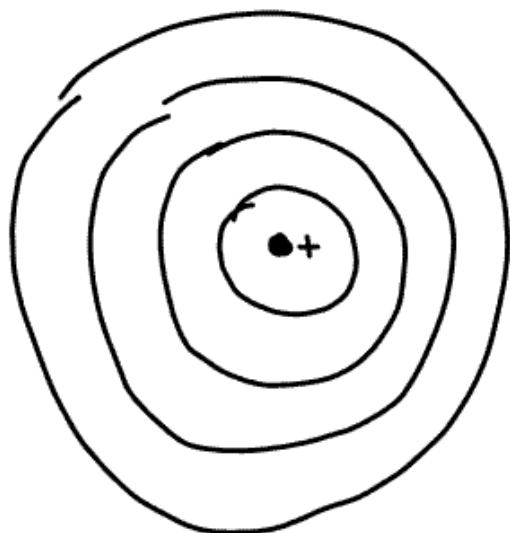
Look on p 196 of Hobson to determine the region of the electromagnetic spectrum where light of this frequency would be found.

2



An atom has 3 possible energy states in which the electron could exist. How many spectral lines could be emitted by this atom?

3



An atom has 4 possible energy states in which the electron could exist. How many spectral lines could be emitted by this atom?

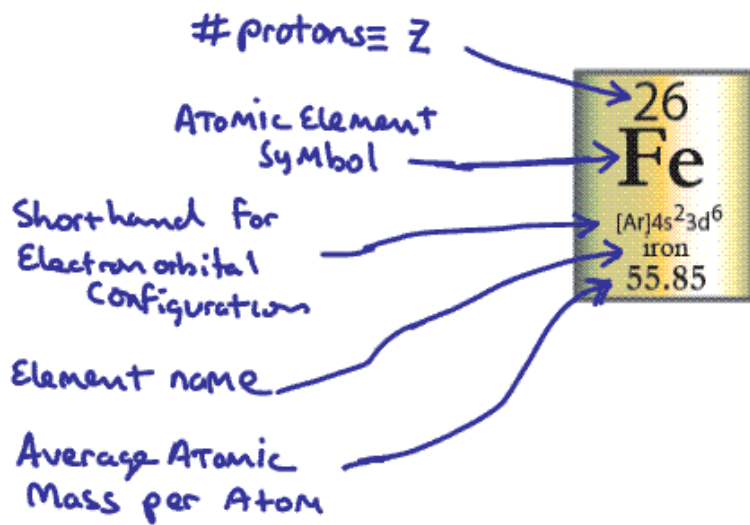
④ IT happens that when you calculate the energy of a multi-electron atom using a full-blown quantum mechanical treatment, the atom is most stable if it has all the possible quantum states in its outermost energy level filled.

⑤ 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 (don't use 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 $\text{Ar} \equiv \text{Argon}$
 $Z=10$ $Z=18$

Los Alamos National Laboratory Chemistry Division

Periodic Table of the Elements

1A																	8A				
1	2																	18			
H	He																	Ne			
1.008	4.003																	20.18			
3	4																	9			
Li	Be																	F			
6.941	9.012																	18.998			
11	12																	17			
Na	Mg																	Cl			
22.990	24.305																	35.453			
19	20																	36			
K	Ca																	Kr			
39.098	40.078																	83.80			
37	38																	54			
Rb	Sr																	Xe			
85.468	87.62																	131.29			
55	56																	86			
Cs	Ba																	Rn			
132.91	137.33																	222			
87	88																	118			
Fr	Ra																	Uuo			
223	226																	[?]			
3A	4A	5A	6A	7A																	
5	6	7	8	9																	
B	C	N	O	F																	
10.811	12.011	14.007	15.999	18.998																	
13	14	15	16	17																	
Al	Si	P	S	Cl																	
26.982	28.086	30.974	32.06	35.453																	
31	32	33	34	35																	
Ga	Ge	As	Se	Br																	
69.723	72.64	74.922	78.96	79.904																	
49	50	51	52	53																	
In	Sn	Sb	Te	I																	
114.818	118.71	121.757	127.6	126.905																	
81	82	83	84	85																	
Tl	Pb	Bi	Po	At																	
204.384	207.2	208.980	209	210																	
	114		116																		
	Uuq		Uuh																		
	(296)		(298)																		
12B	8B										11B										
30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13				
Zn	Cu	Ni	Co	Fe	Mn	Cr	V	Ti	Sc	Ca	K	Ar	Br	Se	P	S	Cl				
65.38	63.546	58.933	58.933	55.845	54.938	52.00	50.942	47.88	44.956	40.078	39.098	36.96	79.904	78.96	74.922	72.64	70.907				
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31				
Cd	Ag	Pd	Rh	Ru	Tc	Mo	Nb	Zr	Y	Sr	Rb	Kr	As	Ge	As	Se	Br				
112.411	107.868	106.42	101.07	101.07	98.906	95.94	92.906	91.224	88.906	87.62	85.468	83.80	74.922	74.922	74.922	72.64	70.907				
80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63				
Hg	Au	Pt	Ir	Os	Re	W	Ta	Hf	La*	Ba	Cs	Xe	Te	Sb	Te	Se	Br				
200.59	196.967	195.084	192.22	193.22	186.207	183.84	180.948	178.49	138.905	137.327	132.905	131.29	127.6	126.905	126.905	124.96	121.757				
112	111	110	109	108	107	106	105	104	89	88	87	86	85	84	83	82	81				
Uub	Uuu	Ds	Mt	Hs	Bh	Sg	Db	Rf	Ac~	Ra	Fr	Rn	At	Po	Bi	Pb	Bi				
(113)	(292)	(271)	(268)	(265)	(263)	(261)	(262)	(261)	(227)	(226)	(223)	(222)	(210)	(209)	(208.980)	(207.2)	(208.980)				
71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54				
Lu	Yb	Tm	Er	Ho	Dy	Tb	Gd	Eu	Sm	Pm	Nd	Pr	Ce	La*	Ba	Cs	Xe				
174.967	173.054	168.930	167.259	164.930	162.50	158.925	157.25	151.964	144.913	140.908	141.904	138.905	137.327	138.905	137.327	132.905	131.29				
103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86				
Lr	No	Md	Fm	Es	Cf	Bk	Cm	Am	Pu	Np	U	Pa	Th	Ac~	Ra	Fr	Rn				
(260)	(259)	(258)	(257)	(254)	(249)	(247)	(247)	(243)	(242)	(237)	(238)	(231)	(232)	(227)	(226)	(223)	(222)				

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*

⑤ 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?

⑥ 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.)