Today: sections 5.5-5.8 - Quantum numbers October 4th

Sunday: Problem club with Kendall

Monday: Finish ch.5

Tuesday: Expt. 7

Tiny world | **Big world**

$\lambda = 486\ nm \left| \dfrac{1\times10^{-9}\ m}{1\ nm} \right. = 4.86\times10^{-7}\ m$ (↑ START) $E = kJ/mol$

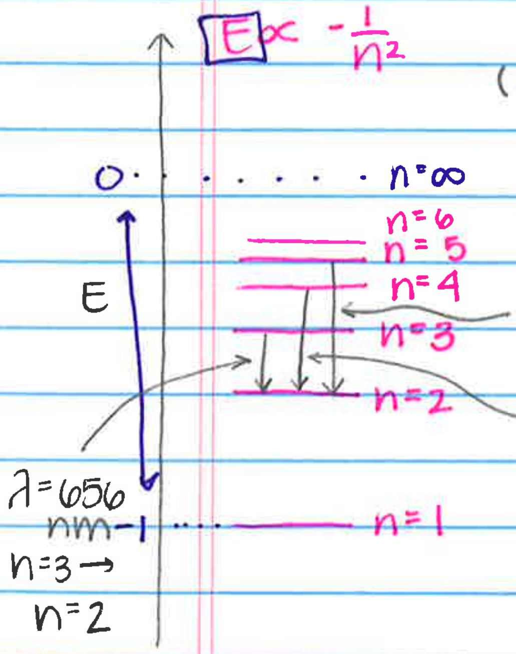
ν

E

$E = h\nu = \dfrac{hc}{\lambda} = \dfrac{6.626\times10^{-34}\ J\cdot s \mid 2.998\times10^{8}\ m}{s \mid 4.86\times10^{-7}\ m} = 4.09\times10^{-19}\ J$

$E = \dfrac{4.09\times10^{-19}\ J \mid 6.022\times10^{23} \mid 1\ kJ}{\mid 1\ mol \mid 1\times10^{3}\ J} = \boxed{246\ kJ/mol}$

$\boxed{E} \propto -\dfrac{1}{n^2}$



$n=?\ (>3) \rightarrow n=3$ (not too much energy)
↳ infrared

$\lambda = 434$ nm (blue)
$n=5 \rightarrow n=2$

$\lambda = 486$ nm (green)
$n=4 \rightarrow n=2$

$n=? \rightarrow n=1$
<u>Lots</u> of energy released (UV)

↓ emits energy   ↑ absorbs energy

* to remove an electron from (n=1 level)
↳ $n=1 \rightarrow n=\infty$
↳ $E>0$

*energies go from 0 to -1 on a relative scale

October 4th

$\frac{1}{\lambda} = 1.097 \times 10^{-2}\ nm^{-1} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$\Delta E = E_f - E_i = -2.178 \times 10^{-18}\ J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

→ TINY WORLD

$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E} \xrightarrow{E=mc^2} \frac{hc}{mc^2} = \frac{h}{mc}$

→ de Broglie for slower objects (not photons)

$c \rightarrow v$

→ $\boxed{\lambda = \frac{h}{mv}}$

Quantum Mechanics (quantum numbers)

① electrons behave as waves in an atom

② Location and speed cannot be determined for any electron. We can predict the probability of finding the e^- at any location

③ Electrons occupy orbitals. Each orbital is described by 3 numbers (quantum). Each orbital can hold up to $2e^-$

④ n is the first quantum number and it's the energy quantum number

→ $E \propto -\frac{1}{n^2}$

⑤ Shape quantum number $n\ [0 \leq \ell \leq n-1]$

n	ℓ
1	0
2	0, 1
3	0, 1 or 2
4	0, 1, 2 or 3

Common notation

If $\ell = 0$ "s orbital"

1s 2s 3s 4s ... 895s

(↑ n, ↑ $\ell = 0$)

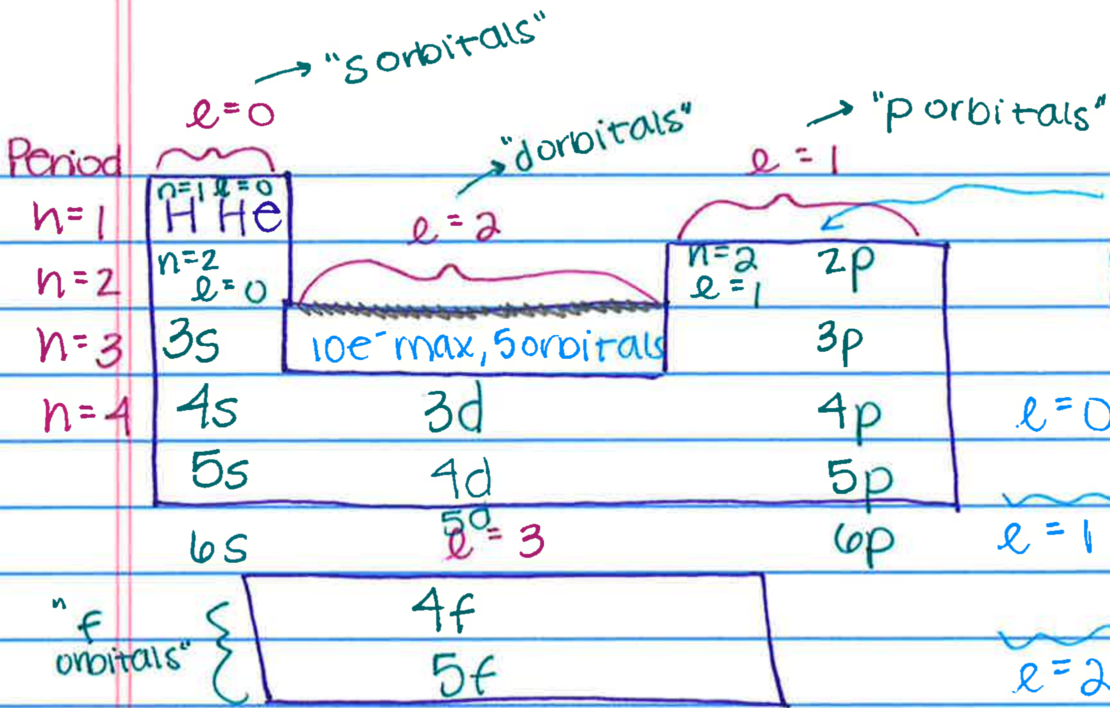
If $\ell = 1$ "p orbital"

2p 3p 4p 5p ... 2712p ... ∞p

If $\ell = 2$ "d orbital"

If $\ell = 3$ "f orbitals"

October 4th



2p elements (six of them)

need 3 orbitals

$\ell=0$ 1 orbital → 2 electrons

$\ell=1$ 3 orbitals → 6 electrons

$\ell=2$ 5 orbitals → 10 electrons

2p orbitals (3 of them)

n = 2, ℓ = 1, $m_\ell = -1$	n = 2, ℓ = 1, $m_\ell = 0$	n = 2, ℓ = 1, $m_\ell = +1$

ℓ	m_ℓ
0	0
1	-1 0 +1
2	-2 -1 0 +1 +2
3	-3 -2 -1 0 +1 +2 +3
14	-14 . . . 0 . . . . . +14

Demonstration: $C_{12}H_{22}O_{11} + NaClO_3 \rightarrow CO_2 + H_2O + NaCl$

Chapter 5 Day 2 (Sections 5.5 – 5.8) (Unit 3) 4 October 2019

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112		114		116		118

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

1. Which of the following sets of quantum numbers is not allowed? Explain what is wrong.

a. n = 4; *l* = 2; m_l = 2	b. n = 1; *l* = 1; m_l = 0	c. n = 3; *l* = 3; m_l = -2
d. n = 4; *l* = 0; m_l = 1	e. n = 5; *l* = 2; m_l = -2	f. n = 4; *l* = 3; m_l = -3

2. Write the following sets of quantum numbers using the s, p, d, and f designations. The first one is done for you.

a. n = 4; *l* = 2; m_l = 2 4d	b. n = 5; *l* = 3; m_l = -3	c. n = 3; *l* = 0; m_l = 0
d. n = 2; *l* = 1; m_l = -1	e. n = 1; *l* = 0; m_l = 0	f. n = 3; *l* = 2; m_l = -2

3. What values for *l* are allowed for each of these values of n? The first one is done for you.

a. n = 4; *l* = ? *l* = 0…3	b. n = 5; *l* = ? *l* =	c. n = 3; *l* = ? *l* =
d. n = 2; *l* = ? *l* =	e. n = 1; *l* = *l* =	f. n = 74; *l* = *l* =

4. What values for n are allowed for each of these values of *l*? The first one is done for you.

(a) n = ?; *l* = 3 n > 3	(b) n = ?; *l* = 1	(c) n = ?; *l* = 0
(d) n = ?; *l* = 4	(e) n = ?; *l* = 2	(f) n = ?; *l* = 37

5. What values for n and *l* are allowed for each of these values of m_l =? The first one is done for you.

a. n = ?; *l* = ?; m_l = -2 n > *l* and l ≥ 2	b. n = ?; *l* = ?; m_l = 3	c. n = ?; *l* = ?; m_l = 0
d. n = ?; *l* = ?; m_l = -1	e. n = ?; *l* = ?; m_l = 4	f. n = ?; *l* = ?; m_l = 15

6. List the orbitals in order of increasing energy (aufbau principle) up through barium, atomic number 56. The series has been started for you:

1s, 2s, 2p,

Questions in final exam format (multiple choice):

7. What are the possible values of *l* if *n* = 5?

A. 5
B. 0, 1, 2, 3, or 4
C. -4, -3, -2, -1, 0, +1, +2, +3, or +4
D. -5, -4, -3, -2, -1, 0, +1, +2, +3, +4, or +5

8. The subshell designations follow the alphabet after *f*. What is the first shell in which an *h* orbital would be allowed?

A. fifth B. sixth C. seventh D. eighth

Now try these problems from the book:

Section 5.5. (de Broglie) (Heisenberg) Read sections, but no assigned problems

Section 5.6. (Quantum mechanical model) Problems 11, 12 (typo in book – they call it Apply 5-10 – should be Apply 5.12) 78, 80, 82, 84, 86, and 88.

Section 5.8. (Orbital shapes) Problems 13, 14, and 28.

Practice Exam (pg 199 – 201), Problem 10