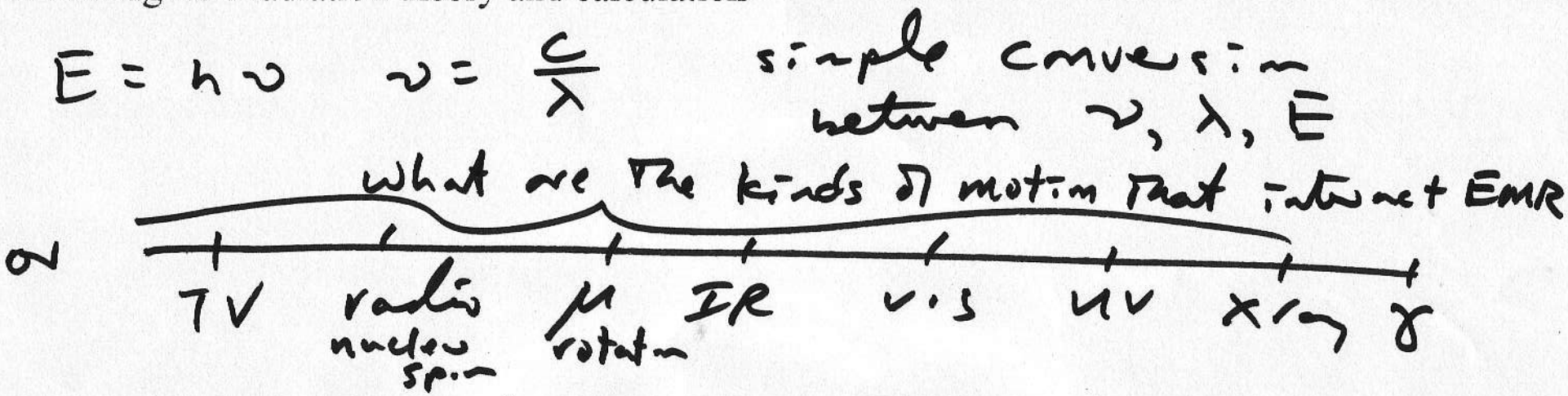
CH301 Fall 2008 Exam 1 question types

1. electromagnetic radiation theory and calculation

$E = h\nu$ $\nu = \frac{c}{\lambda}$ simple conversion between ν, λ, E



or know about oscillators interacting

2. classical theory falls apart (blackbodies, photoelectric effect and atomic emission)

blackbody radiation: ever notice that even though you radiate you don't give off UV rays

photoelectric effect: says that e^- can be ~~em.~~ ejected by any kind of light if intensity is large enough

atomic emission: exhibits discrete lines rather than a continuum of light when you zap gases

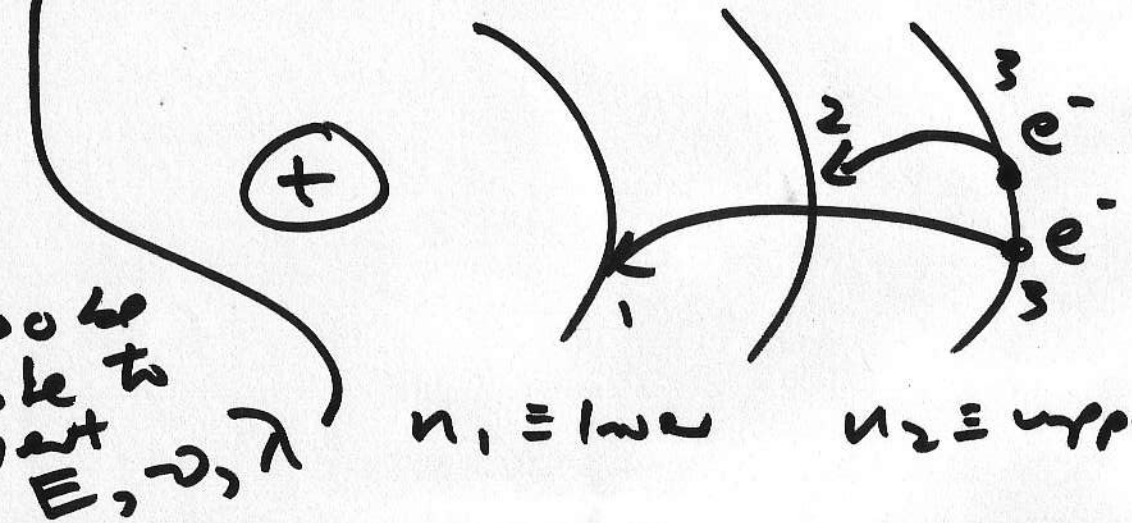
$\nu = R\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$

3. Rydberg equation calculation

a classic plug + chug

$$\nu = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

know difference between
Balmer $n=2$
Paschen $n=3$
Lyman $n=1$

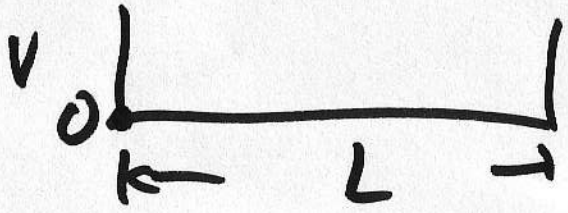


also be able to convert E, ν, λ

$n_1 \equiv$ lower $\quad n_2 \equiv$ upper

4. particle in a box theory

There are certain out comes from Schrodinger equation soln when when $V = 0$



know the solutions, know the relationship between E, λ, L_{yn} (These are given in list of equations) and need to know the 3 or 4 things everyone knows about particle in a box

5. uncertainty principle [redacted] calculation

plug and chug
calculation. Don't think, do.

$$\Delta x \Delta p \geq \frac{h}{2}$$

$$\Delta x \, m \Delta v \geq \frac{h}{2}$$

make sure you make your units cancel (kg, meters, s)

6. deBroglie equation [redacted] calculation

→ d.H.O

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

d.H.O ←

7. Schrodinger and wave equations: theory

5 things to know

- finds solutions to wave eqn for matter
- ψ^2 yields probability density for e^-
- E is generated to be related to $h\nu$
- For H atom there are 4 boundary conditions. n, l, m_l, m_s
- tells us where all e^- in multi e^- system are (1s, 4d, 5f, etc)

8. applying quantum number rules

One of these problems will challenge your knowledge of boundary conditions.

$n = 1, 2 \ldots \infty$

$l = 0, 1, 2 \ldots n-1$

$m_l = -l, \ldots 0, \ldots +l$

$m_s = +\frac{1}{2}, -\frac{1}{2}$

knowing this will let you solve problem

9. applying quantum number rules

I will ask something like

"How many (e^- / orb.tls / subshells) are in (orb.tls / subshells / shells)

Example: How many e^- in a 2d orb.t? 0
how many orb.tls in n = 3? 9

10. applying Aufbau, Pauli and Hund

Daniel will create some crazy picture of electrons in orb.tls:

↑↓ ↑↓ ↑ ↑ —

and you will use ↑ to say what is right and wrong.

↑↓ ↑↓ ↑ ↑ ↑ is really wrong.

11. assigning electronic configurations of atoms and ions

I will give you an atom or ion. You convert it into a number of e^- and then follow Aufbau, Hund, Pauli to give me an e^- configuration.

Example C has what conf. $[He]2s^2 2p^2$

or Al^+ " " " $[Ne]3s^2$

12. assigning electronic configurations of atoms and ions (exceptions)

Except, sometimes Aufbau doesn't work. Like the $s^2d^4 \rightarrow s^1d^5$ or $s^2d^9 \rightarrow s^1d^{10}$ cases. So expect one of these.

Example, what is the e^- configuration for Ru^{++}? $[Kr]5s^1 4d^5$

13. assigning electronic configurations of atoms and ions (exceptions)

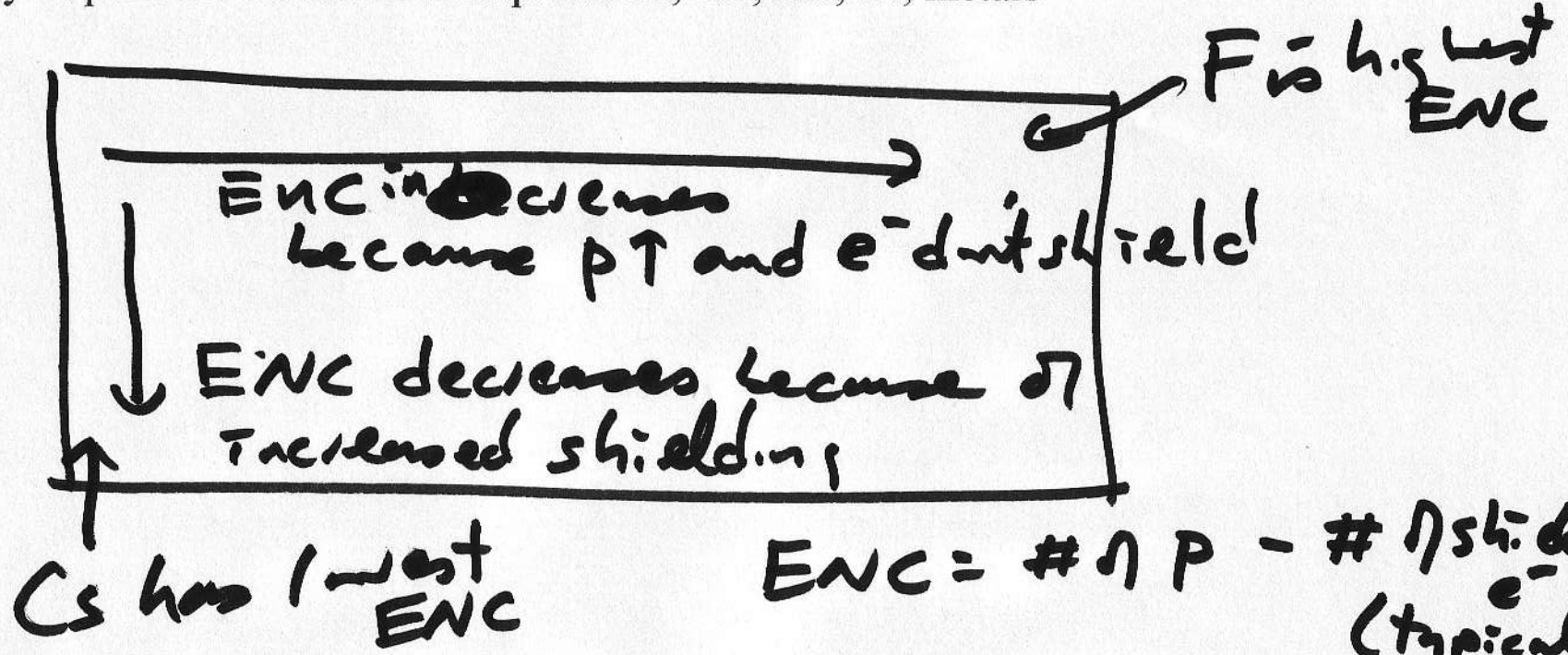
Except of main group p block metallions
Things like In^{+3}, Bi^{+5}, Sn^{+4}
the answer is not s^2d^8 but rather s^0d^{10}

14. periodic table nomenclature

know a bunch of words you should have learned in H.S.

main	alkali metal
block	alkali earth
period	group
lanthanide	row
Adogle	column
halogen	family

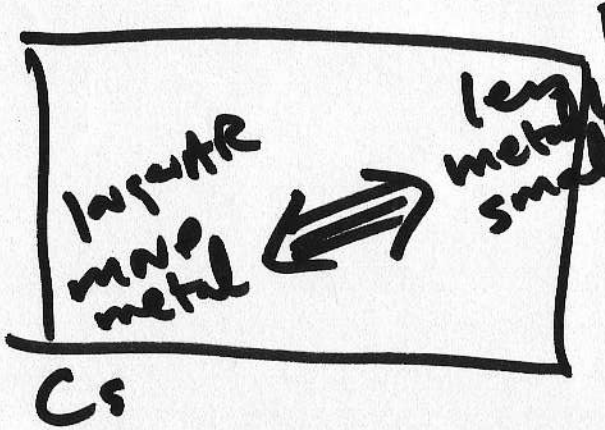
15. theory of periodic trends: ENC explains IE, EA, AR, IR, metals



ENC = # of p − # of shielding e⁻ (typically 2 or 10)

16. ranking periodic trends: IE, EA, AR, IR, metals

not exceptions



or be able to rank

Ionic radius by rearranging to isoelectronic and comparing ENC or p vs e⁻

Example

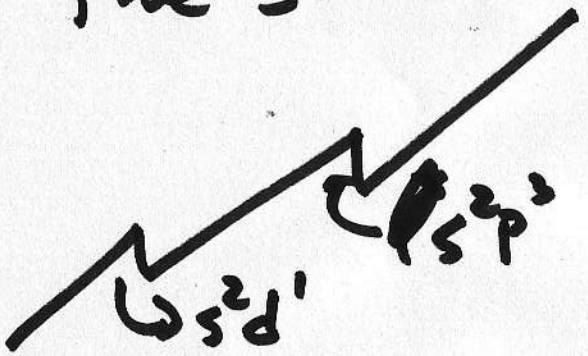
much smaller ⇒ Al^{+3} $10, 5p$

N^{-3} $10, 7p$ ⇐ much larger

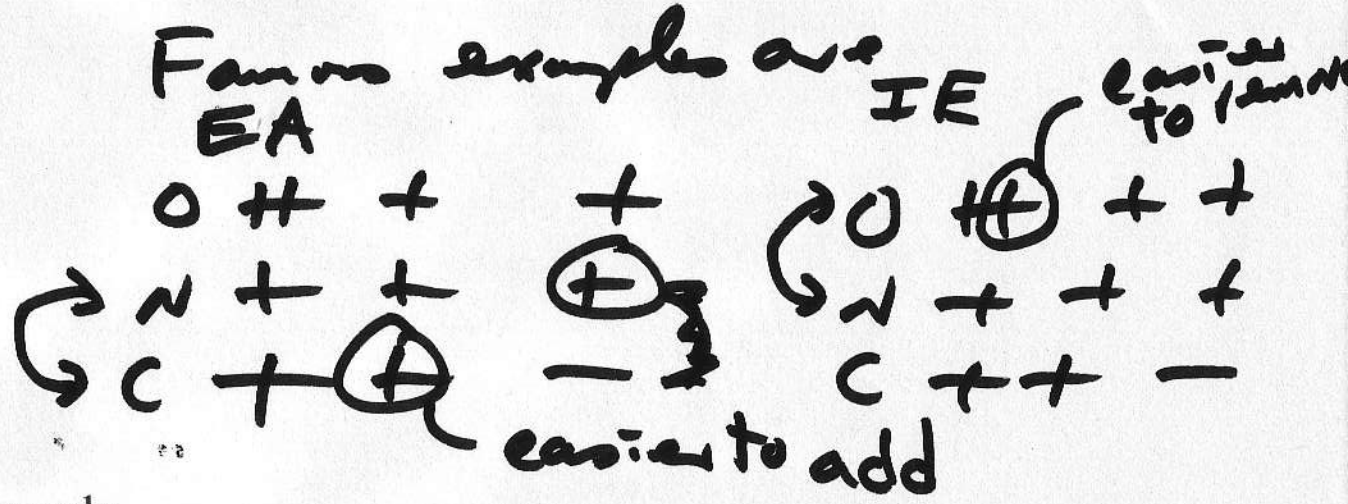
17. ranking periodic trends: IE, EA, AR, IR, metals (exceptions)

more than just ENC matters.
filled + half filled shells rear their heads.

five structure



Famous examples are



18. Lewis structures of ionic compounds

I will want to give you a salt of form

AB, AB_2, A_2B ..... A_3B_2

9 of them

Example $CaCl_2$ → you tell me it is

Ca^{++}, $2\left[:\ddot{\underset{\cdot\cdot}{Cl}}:\right]^-$

19. Lewis structures of covalent compounds, resonance

The next 7 are done the same way to start.

- spread out atoms
- count valence e⁻
- add 2H ● or 8 all other perimeter
- dump the rest in the middle.
- Fix it.

For resonance, fixing means borrowing e⁻ pair from perimeter to make double bond. But there will be multiple sites from which to take e⁻. Examples

20. Lewis structures of covalent compounds, multiple central atoms

As long as you spread out the atoms correctly, with H + Cl like atom on perimeter, you do it the same way as a single central atom.

Example C_2H_2 H-C≡C-H

SO_2 SO_3

NO_2^- NO_3^-

O_3 $CO_3^=$

↑ ↑3

2 resonance structure cases

structure cases

21. Lewis structures of covalent compounds (exceptions to octet, too odd)

These are radicals. Add up the valence e^-, and if it is an odd number you have a radical

like BrO or NO

13 e^- 11 e^-

22. Lewis structures of covalent compounds (exceptions to octet, too small)

The hypovalent cases involve group I, II, III elements that can't form 4 bonds. Duh

II ↑ Be

III ↑ B

23. Lewis structures of covalent compounds, multiple bonds

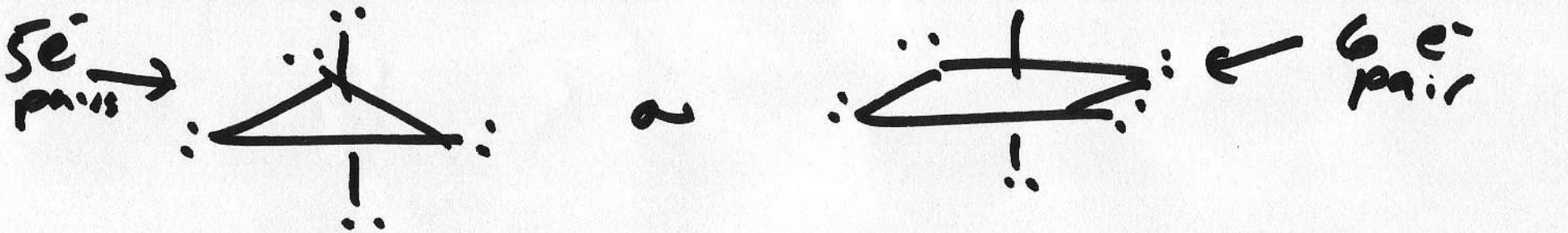
Do first 4 steps and then borrow enough e^- from perimeter to satisfy octet for all central atoms

CO_2 N_2 SCN^-

$\ddot{O}=C=\ddot{O}$ $\ddot{N}\equiv\ddot{N}$ $\ddot{S}=C=\ddot{N}^-$

24. Lewis structures of covalent compounds (exceptions to octet, too large)

After the first 4 steps, you have dumped e^- into the middle atom. Have more than 4 e^- rich region.



25. Lewis structures of covalent compounds (exceptions to octet, too large)

Examples include

SF_6, PCl_5, I_3^-, XeF_2, blahblahs

Hint need to be able to count:

examples of questions or multiple answers

- # of e^- pairs
- # of bonding e^- pairs
- # of nonbonding e^- pairs or points
- # of bonding e^- # of nonbonding e^- etc

26. ranking crystal lattice energy

charge density argument

$+3 > +2 > +1$

$-3 > -2 > -1$

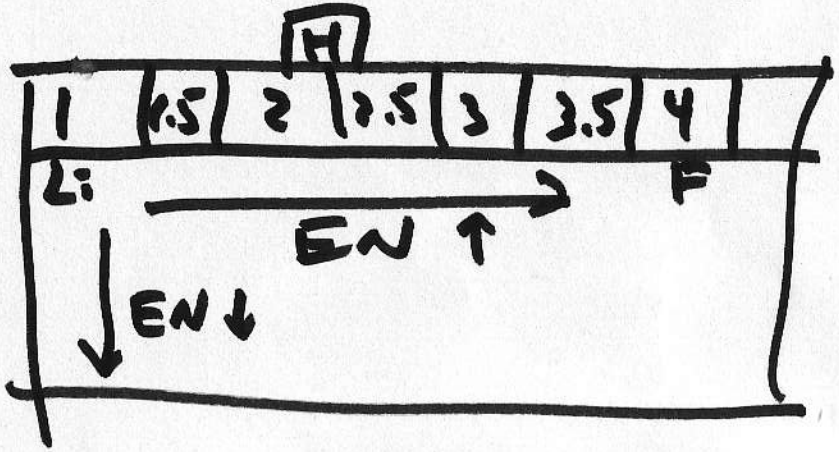
greater energy — less energy

Example

CaO > LiF > NaCl

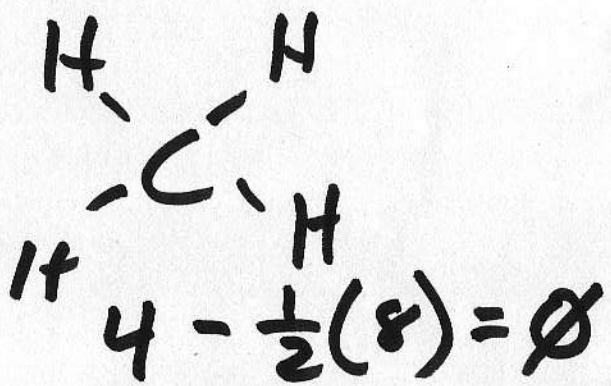
$\oplus$ in Li vs $\oplus$ in Na

27. electronegativity calculation and ranking



28. assigning formal charge

Formal charge = (# of valence e^- for an atom) − (all the nonbonding e^- + ½ bonding e^-)



$4 - \frac{1}{2}(8) = 0$

29. formal charge and correct Lewis structures

Using Formal charge values for every atom in a slew of reasonable structures, find the combination with the lowest integer #s. That is the correct structure.

Examples in notes 1:6.

SCN^-, CH_2O, BF_3

30. ranking bonding trends: EN, bond energy, bond length

In ranking bond energy or bond length

The — single > = double > ≡ triple

length

As you go down a group, bond energy goes ↓ and length ↑

but the opposite is true for energy

— < = < ≡ ← greater energy